3.0 EXISTING WATERSHED CONDITIONS

3.1 PHYSICAL SETTING

The Pleasant Grove and Curry Creek watersheds are located in western Placer County, including the western portions of the Cities of Roseville and Rocklin and eastern Sutter County. Both of these creeks empty into the Pleasant Grove Creek Canal which drains to the Sacramento River via the Cross Canal (Table 3-1). The combined watershed covers approximately 40,800 acres with elevations ranging from a high of around 590 feet on the eastern boundary to a low of approximately 35 feet where Pleasant Grove Creek meets the Pleasant Grove Creek Canal. The watershed is composed of five major drainages: Curry Creek, Lower Pleasant Grove Creek, Kaseberg Creek, South Branch Pleasant Grove Creek and upper Pleasant Grove Creek as shown in Figure 3-1. Table 3-1 summarizes the areas of these subbasins.

Table 3-1 Subbasin Acreages within the Pleasant Grove Watershed

Subbasin	Approximate Size (acres)
Curry Creek	10,200
Lower Pleasant Grove Creek	12,600
Kaseberg Creek	3,100
South Branch Pleasant Grove Creek	3,900
Upper Pleasant Grove Creek	11,000

3.1.1 Topography

The watershed extends from the base of the Sierra Nevada foothills in the east to the Sacramento River Valley floor in the west. For the majority of the watershed, the topography is primarily defined by the main creek channel and tributaries (Figure 3-2). In general, slopes are very flat, less than five percent, particularly in the lower watershed (Figure 3-3). Primarily along bluffs overlooking creeks in the middle watershed, slopes range from five to ten percent, with some moderate slopes (ten to twenty percent) on steeper banks. The northeastern boundary of the watershed, located in the foothills, is defined by a ridge separating the Pleasant Grove watershed from Clover Valley Creek, and slopes on the western face of this ridge can be as high as fifty percent.

3.1.2 Geology

While detailed geomorphologic analysis of individual sites will be needed prior to implementing restoration projects, a general overview of the watershed geology provides information on the parent material that characterizes the overall soils and drainage patterns in the watershed. The watershed geology spans a timescale that encompasses formations of the Sierra Nevada batholith as well as more recently deposited formations. The youngest geology is that associated with alluvium (Qa) found in a few small pockets in the central part of the watershed. The western half of the watershed is dominated by the Riverbank Formation (Qr) which developed along the east margin of the Sacramento Valley between 130,000 and 450,000 years ago and is made up of moderately weathered reddish arkosic sediments with unconsolidated to semi-consolidated gravel, sand, and silt in dissected alluvial terraces and fans. The Turlock Lake Formation (Qtl) which developed between 450,000 and 600,000 years ago is found throughout most of the central part of the watershed. It is composed of deeply weathered reddish arkosic sediments of semi-consolidated gravel, sand, and silt in highly dissected alluvial fans. The Mehrten Formation (Tva) is still older (late Miocene to early Pliocene) and is found along the eastern, most elevated portion of the watershed. It consists of undifferentiated Tertiary andesitic mudflows, volcanic breccias, pyroclastic deposits, lava flows, and sedimentary fluvial deposits composed almost entirely of andesitic material. The oldest formation is a small pocket of Mesozoic intrusive granitic rock (Mzg) of the Sierra Nevada batholith that is located in the most northeasterly corner of the watershed.

3.1.3 Soils

The General Soil Map of the Soil Survey of Placer County (Western Part) identifies five broad categories or series of mapped soil units which occur within the watershed. The mapped soil series correspond very closely with the mapped local geologic units. The five series may be divided into two categories that are distinguished by location and parent material.

Series 1 through 3 are soils on terraces and alluvial bottoms. These soils occur in the western and central part of the watershed where the corresponding mapped geologic units were quaternary sedimentary deposits (i.e., the Riverbank and Turlock Lake formations, and recent alluvial channel deposits). These major soil series are:

1 – San Joaquin-Cometa Series – Undulating, moderately deep to deep, well-drained soils that have a dense clay subsoil; on terraces.

2 – Fiddyment-Cometa-Kaseberg Series – Undulating to rolling, deep to shallow, well drained soils that are underlain by siltstone; on terraces. Soils in this series occupy the vast majority of the western and central watershed.

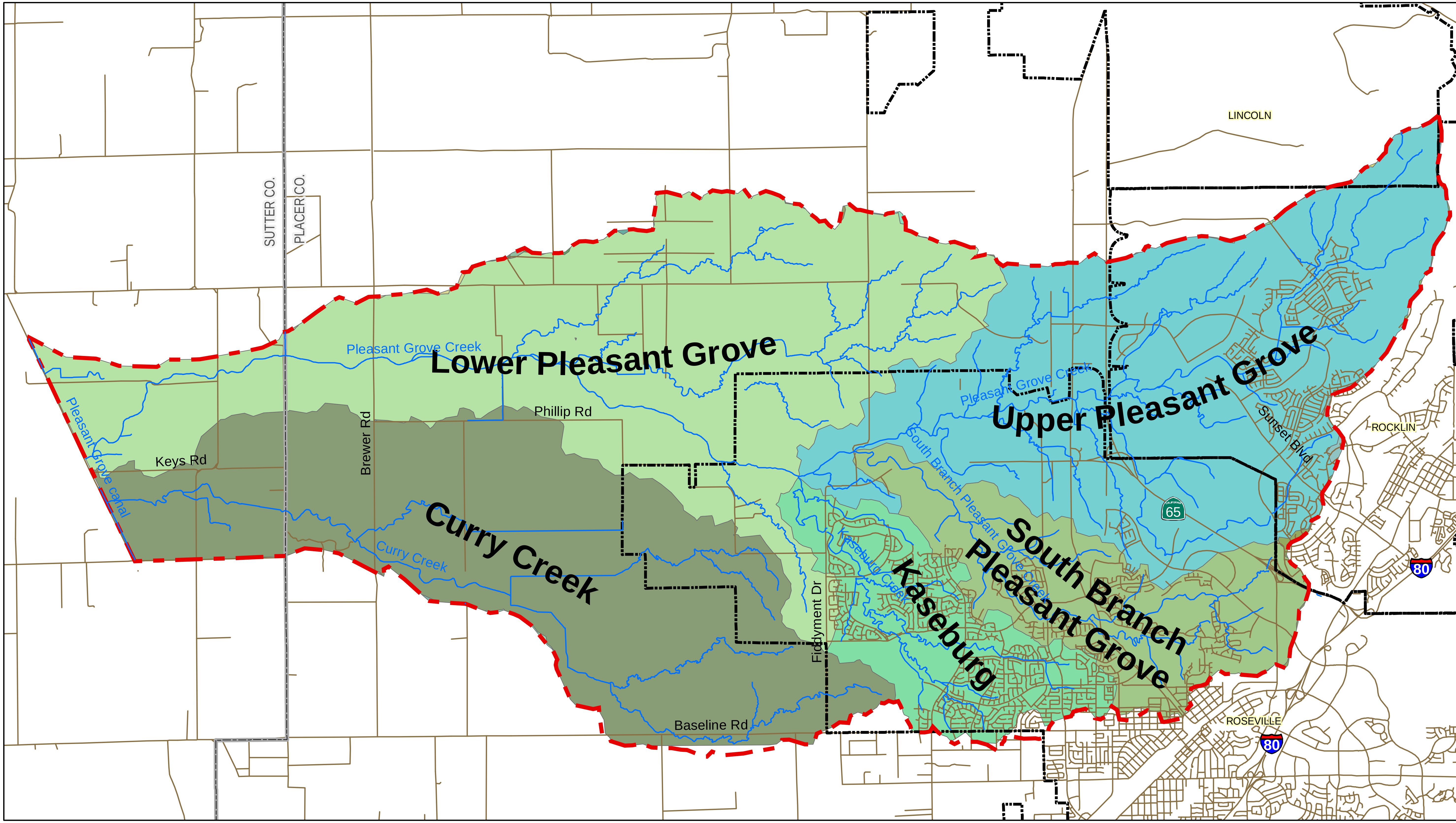
3 – Cometa-Ramona Series – Undulating, deep and very deep, well-drained soils; on terraces.

The remaining two series (6 and 8) are soils on the foothills in the eastern most part of the wartershed. These are:

6 – Exchequer-Inks Series – Undulating to steep, well-drained and somewhat excessively drained soils that are shallow over volcanic rock. These soils correspond to areas where the Mehrten Formation (Tva) crops out.

7 – Andregg-Caperton-Sierra Series – Undulating to steep, well-drained and somewhat excessively drained soils that are deep to shallow over granitic rock. These soils correspond to areas where the Mesozoic granite (Mzg) crops out.

Soil textures in the watershed are primarily sandy loams, clay/silty loams and clays (Figure 3-4). The majority of the watershed is clay/silty loam with areas of sandy loam in the lower elevations and the northeast corner below the ridge. Clay soils occur primarily in the lower and middle watershed along historic floodplains of Curry Creek and northern Pleasant Grove Creek tributaries.



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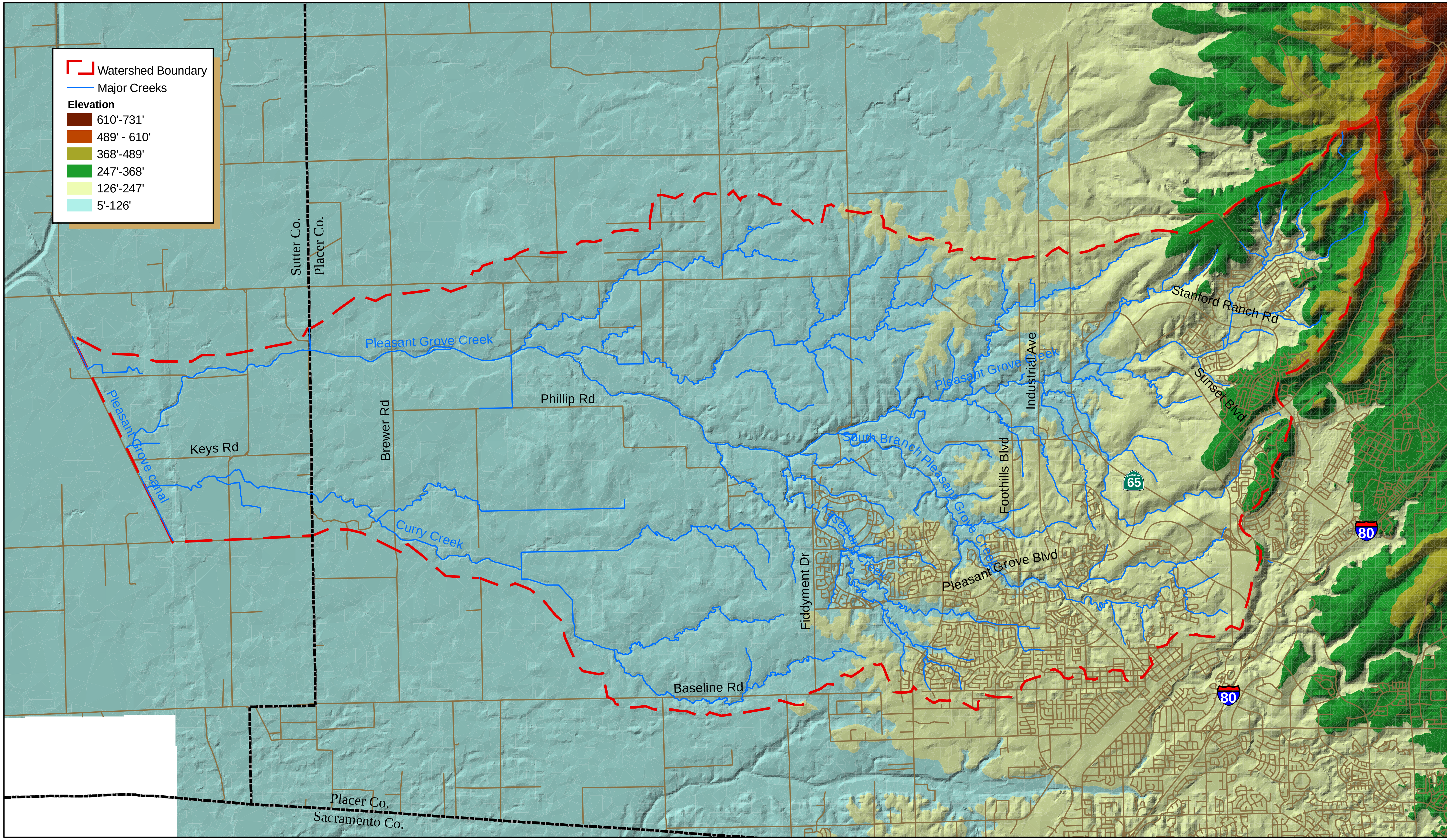
MAJOR SUB-BASINS

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 0.5 1
MILES

FIGURE 3-1

Fig-2_subbasins_major.mxd



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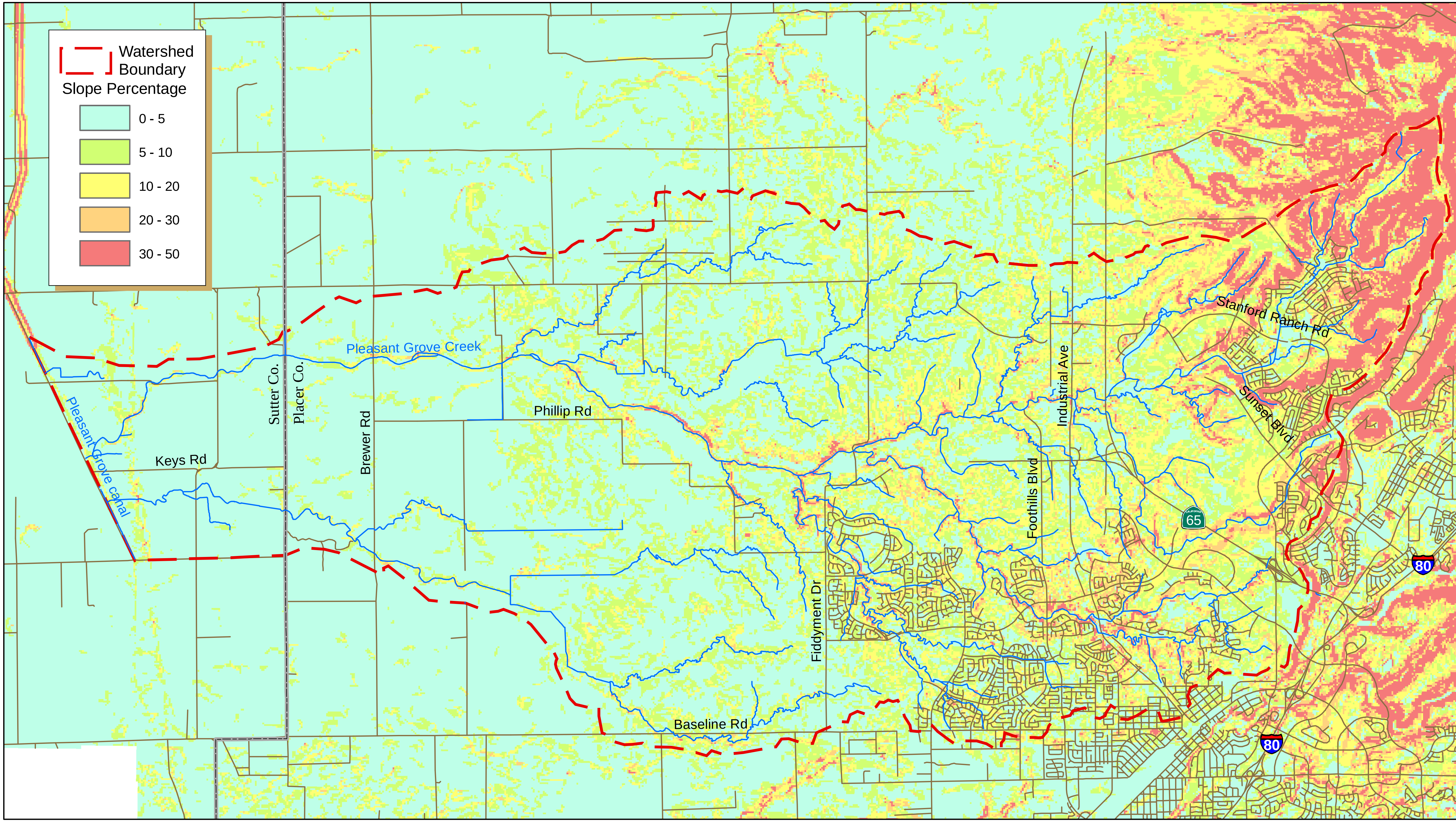
TOPOGRAPHY

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 0.4 0.8
MILES

FIGURE 3-2



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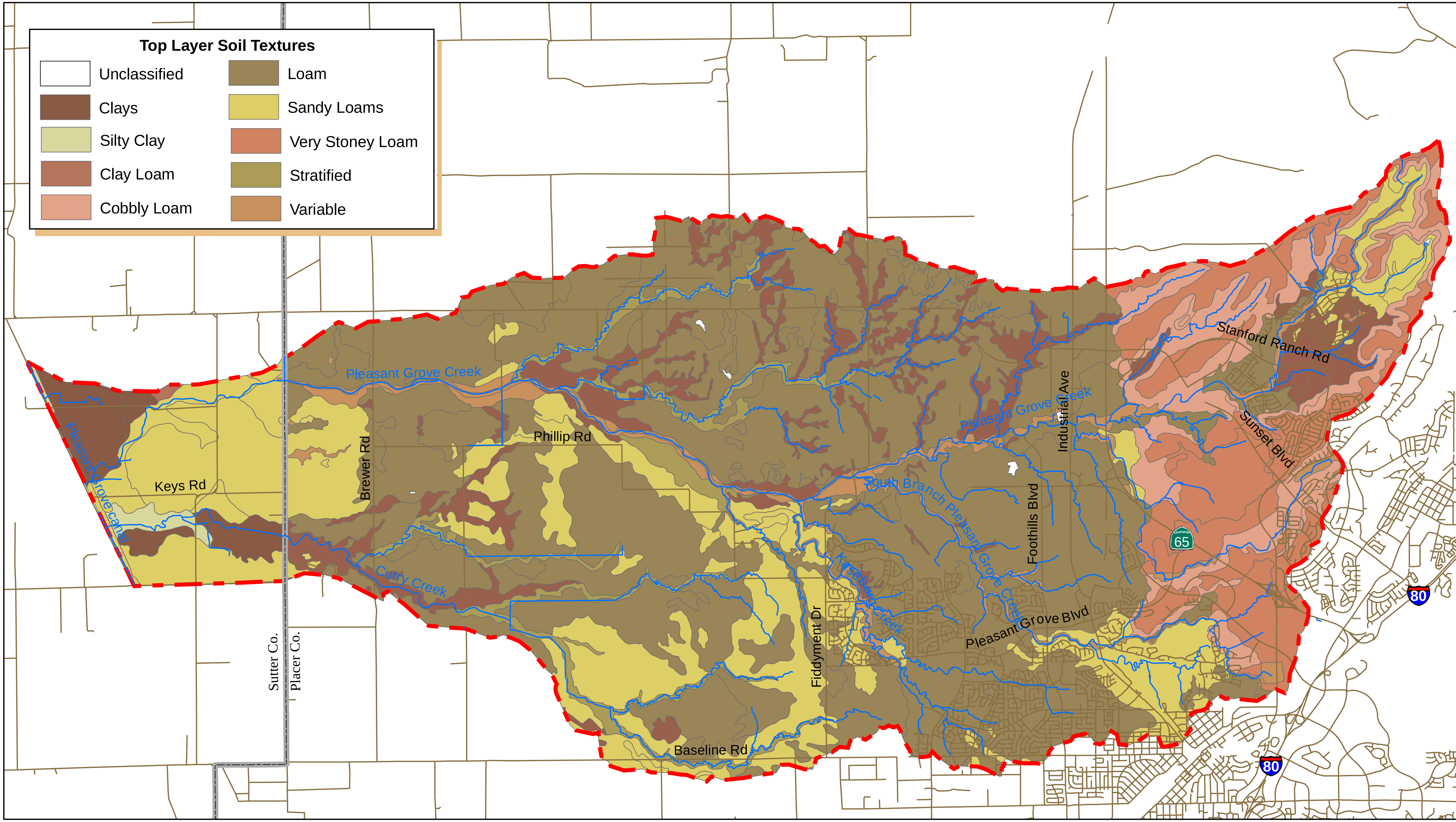
SLOPE MAP

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

FIGURE 3-3

Fig-3-3_slope.mxd



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SOIL TEXTURES

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 0.5 1
MILES

FIGURE 3-4

3.2 LAND USE/LAND COVER

The dominant land cover types within Placer County are annual grasslands (approximately 39% of total watershed area), urban and suburban (approximately 24% of total area), and agriculture (approximately 26% of total area). Urban and suburban land uses within the watershed are currently confined to the eastern watershed in the Cities of Roseville and Rocklin and the Town of Loomis, although both urban and suburban land uses are expected to see significant growth in the next ten years.

The watershed was historically dominated by agriculture. Agricultural uses occur primarily in the western Placer County and Sutter County portions of the watershed. Rice accounts for 43% of all agriculture in the watershed, rice crops being both Sutter County's and Placer County's leading agricultural industry in 2003. Rice farming in the lower watershed is very active with farmers growing white, wild and organic rice. Agriculture in the middle watershed is primarily rice farming and cattle ranching on unirrigated grasslands. Other row crops in the watershed amount to 10% of agricultural uses, and orchards and vineyards make up less than 1%. A 43 acre pistachio orchard owned by David Fiddyment occupies the south bank of Pleasant Grove Creek at the confluence of Pleasant Grove and South Branch Pleasant Grove Creeks. This farm was recently sold and is salted for development. Agricultural land owners are currently working with local and state agencies to implement the new Irrigated Lands Conditional Waiver, commonly referred to as the Ag Waiver, which attempts to regulate and monitor agricultural impacts to water bodies.

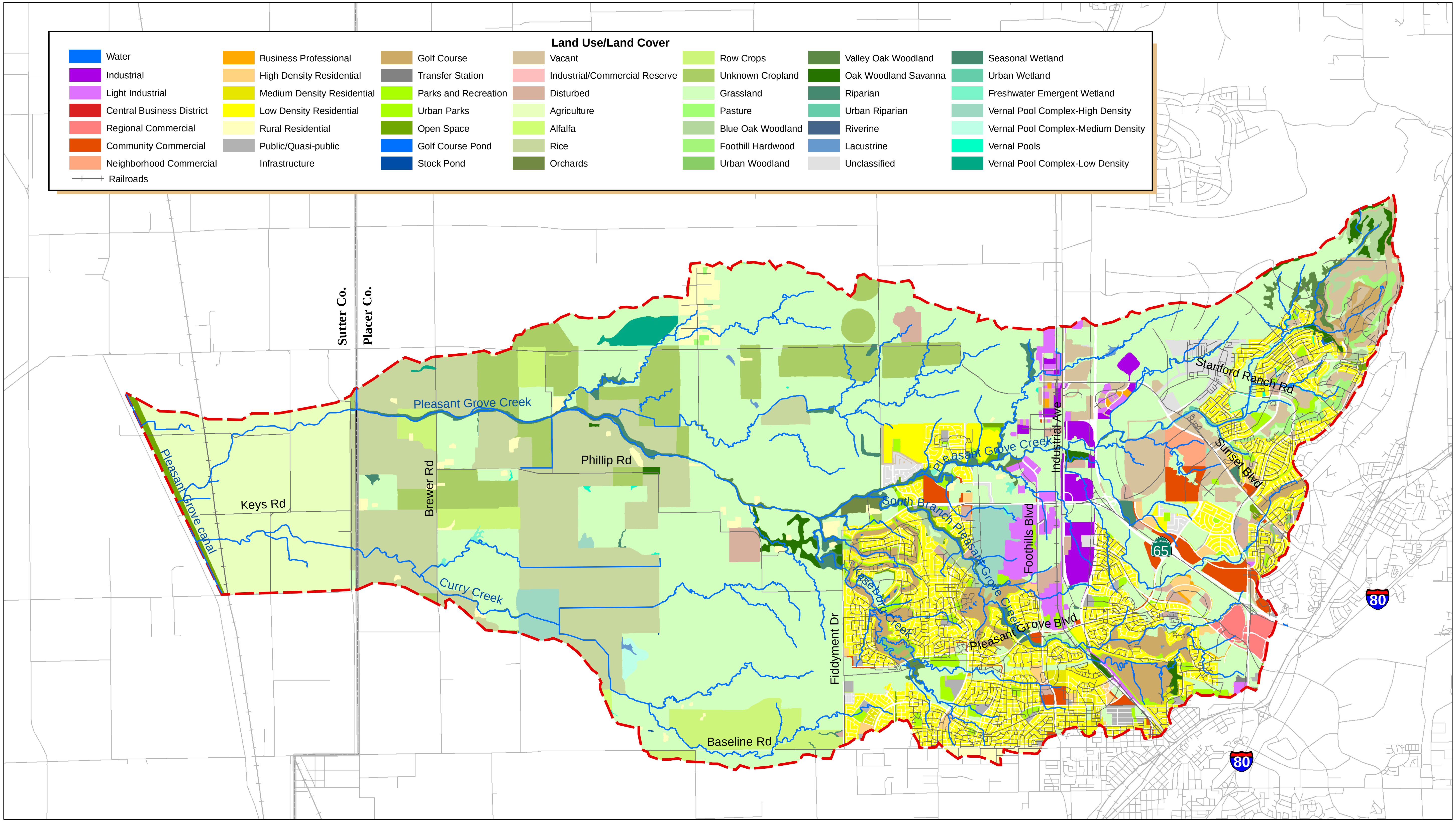
Current development trends in the watershed are resulting in conversion of agricultural and grass lands to suburban land uses: predominantly low to medium density residential communities with associated neighborhood or community commercial. It is likely that this trend will continue into the near future.

Other less dominant land cover types occur throughout the watershed. Riparian and woodland classes typically occur sporadically along the stream corridors, depending upon whether past land use practices allowed remnant woodlands to remain. Seasonal wetlands and vernal pools are scattered throughout the lower elevations of the watershed where soils and topography support them. A large vernal pool complex is located in the central watershed northwest of Sunset Boulevard and Amoruso Way. A large irregular patch of oak woodland savannah lies between Kaseberg Creek and an unnamed tributary to Pleasant Grove Creek in the central watershed. Additional patches of oak woodland savannah and valley oak woodland are prevalent in the upper watershed east of Whitney Boulevard and north of Park Drive.

Figure 3-5 presents the existing land use/land cover pattern for the watershed, compiled from Placer County Parcel data, Sutter County land use data and vegetation classification data from the Placer County Habitat Conservation Plan project. Table 3-2 presents the approximate acreages for the existing land use/land cover conditions within the watershed, derived from the land use/land cover map.

Table 3-2 Existing generalized land use/land cover acreages

WATERSHED LAND COVER	ACREAGE
Industrial	909
Business Professional	43
Commercial	730
Residential	4,702
Infrastructure	1,017
Public/Quasi-Public	226
Parks and Recreation	1,479
Transfer Station	7
Open Space	191
Urban Reserve	11
Agriculture	10,974
Grasslands	15,433
Orchards	43
Riparian	427
Vacant	1,759
Open Water	64
Wetlands	927
Woodlands	1,035
Unclassified	412



EXISTING LAND USE/LAND COVER

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 2,800 5,600
SCALE IN FEET

FIGURE 3-5

Springfield:\Pleasant_Grove_and_Curry_Creek\GIS_Projects\Fig-3-5_existing_land_use.mxd

3.3 INFRASTRUCTURE

Primary vehicular circulation within the watershed occurs along arterial roads connected to the primary highway corridors Interstate 80 and Highway 65. Major arterial routes within the urbanized areas of Roseville and Rocklin include Foothills Boulevard, Blue Oaks Boulevard, Industrial Avenue, Junction Boulevard, Sunset Boulevard, Stanford Ranch/Harding/Galleria Boulevard, Whitney Boulevard, Park Drive/Pleasant Grove Boulevard, Baseline Road and Fiddyment Road. Primary rural routes in the western portion of the watershed include Phillip Road, Brewer Road, Locust Road, as well as some of the arterials already mentioned such as Sunset Boulevard. The density of roads is dramatically lower in the western watershed than in the eastern portion due to the rural nature and the large size of the agricultural holdings west of Fiddyment Road. The proposed Placer parkway would provide a major east-west route through the watershed connecting from Highway 65 to Sutter County.

The Union Pacific Railroad operates two lines within the watershed. The easternmost of these tracks connects to the main line in the City of Roseville and follows Washington Boulevard for a short distance northwest until it bends north to parallel Industrial Boulevard until it exits the watershed. This line crosses both South Branch Pleasant Grove Creek and Pleasant Grove Creek, as well as several unnamed tributaries to both of these creeks. The other line cuts the western end of the watershed from north to south just east of the Pleasant Grove canal. Both of these lines are still active.

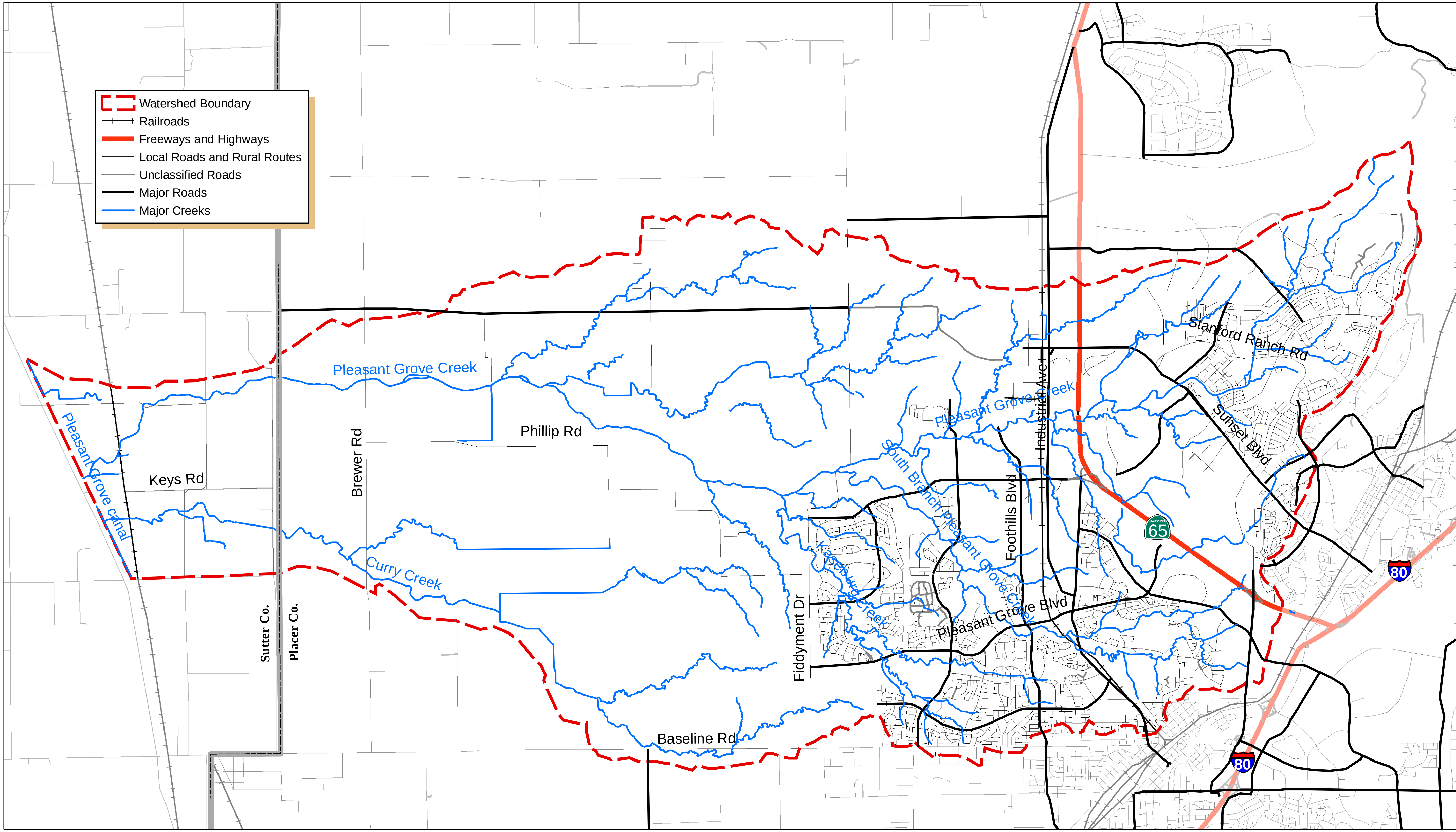
Figure 3-6 illustrates the roads and railways in the watershed.

3.4 POPULATION

Figure 3-7 shows population density in people per acre for the Placer County portion of the watershed. This data is taken from the 2000 census, and while patterns have changed somewhat in the four years since this census due to the rapid growth in western Placer County, the majority of the development has centered around the same primary population centers. Population divisions for this map were selected based upon County General Plan designations for rural, low, medium and high density residential land use in dwelling units per acre, adjusted for the average people per household for the watershed of 2.7.

Total population of the watershed in 2000 was approximately 60,000 people distributed among approximately 22,000 households. These values were calculated from the U.S. census data and using P016001 Total Population in Households and P017001 Households Average Size. All census blocks that were at least partially in the watershed were included. Since the census block boundaries do not conform to the watershed boundaries, portions of some blocks included in the estimate are outside of the watershed. For this reason, the population figures are approximate. The recent and projected growth in the watershed is consistent with the growth seen throughout Placer County in the last 40 years.

The 2003 population estimate for Placer County made by the Placer County Department of Finance was 275,600. This represents an 11 percent increase over that recorded in the 2000 census, or 3.7 percent per year. If the watershed has followed similar trends between 2000 and 2005, the 2004 watershed population would be approximately 69,000 people. Given the growth in west Roseville during this time span, it is likely that the 2004 watershed population exceeded this figure. This projected growth trend is supported by the historical population increases seen in Placer County. Since 1960, the County's population has increased over 300% with the majority of that increase being in the western, urbanizing part of the County.



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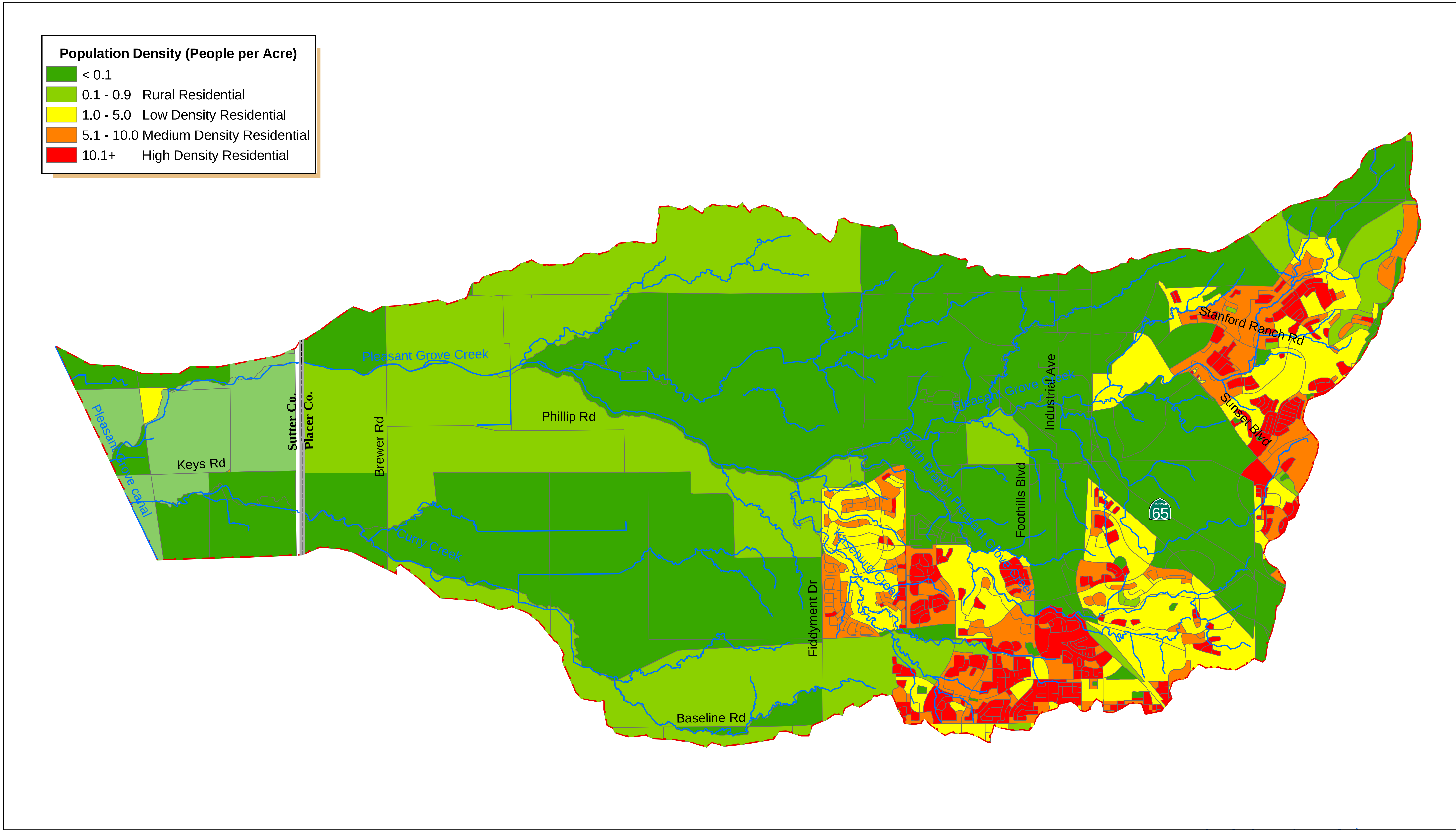
TRANSPORTATION

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 2,750 5,500
FEET

FIGURE 3-6

Springfield:\Pleasant_Grove_and_Curry_Creek\GIS_Projects\WDGT_Report_Figures\Fig-3-6_transportation



POPULATION DENSITY

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 2,800 5,600
SCALE IN FEET

FIGURE 3-7

Springfield:\Pleasant_Grove_and_Curry_Creek\GIS_Projects\WDGT_report_figure\Fig-3-7_population_density_census.mxd

3.5 WATERSHED HYDROLOGY

Pleasant Grove Creek, Curry Creek, and their tributaries are historically intermittent streams, meandering through relatively flat, former or existing agricultural land. The average gradients in these creeks are somewhat less than in the neighboring Dry Creek and Auburn Ravine systems, and the channels are relatively less incised with more gradually inclining banks. However, channel incision is becoming more of an issue in the Pleasant Grove/Curry Creek watershed increased urbanization is contributing to higher volumes of year round runoff. Incision is most evident in the downstream reaches, with lower Pleasant Grove Creek showing cut banks of six or more feet, and lower Curry Creek showing cut banks of five or more feet. Groundwater recharge contributes very little to Pleasant Grove stream flow, in part contributing to its function as a warm water fishery. Additionally, the substrate in Pleasant Grove creeks is generally fine with few small cobbles and gravels that are typically embedded in silt.

3.5.1 Flood Management

Flood management for the watershed is provided by Placer County Flood Control & Water Conservation District (PCFCWCD) in the Placer County portions of the watershed, and Reclamation District No. 1000 (RD 1000) for the Sutter County sections of the watershed. The Federal Emergency Management Agency (FEMA) is currently conducting detailed floodplain mapping of the Pleasant Grove Creek main stem, including updated hydrology and hydraulic models. These models will become the PCFCWCD's future design base models for this watershed. Curry Creek is not included in these studies; however, significant portions of the Curry Creek models have been updated through new development review requirements. The FEMA study will provide detailed information not covered within this document such as flood frequencies, depths, and extents of flooding.

The lower watershed floods regularly with water over topping the banks annually in some areas. This problem is caused by a compilation of several different factors that have occurred both locally in the Pleasant Grove and Curry Creeks watershed and in the greater Sacramento River watershed. Starting in the early 1900's levees and dikes were installed to protect land owners and assist farmers. A result of this practice has resulted in a highly channelized and confined stream system, especially in the lower watershed, which has effectively eliminated the natural floodplain. The confined channels cause increased stream stage heights which then typically results in flooding of areas just upstream of bridges that have become undersized with respect to the increased stage heights. Adding to this problem is an increase in drainage rates off of the upper watershed from the cities of Roseville and Rocklin. Development typically increases the amount of impervious surfaces within a watershed such as roads, parking lots and roofs. All of these impervious surfaces lead to increased runoff volumes and response times to storm events.[3]

However, the single largest factor contributing to flooding in the lower watershed is due to elevated stage heights in the Sacramento River caused by development throughout the drainage basin. The increased stage heights create a pressure head differential which restricts flood waters draining from the watershed from entering the Sacramento River. This causes water to back up through the Cross Canal, up the Pleasant Grove Canal and into both Pleasant Grove and Curry Creeks. According to the studies, water depths will in general increase in the future less than 0.3 feet in the tributaries and approximately 0.1 feet in the ponding areas.[4]

To help mitigate for increased runoff, several projects are being developed. The largest currently planned is the development of an off-site storm water retention facility called Reason Farms, which is planned by the City of Roseville to mitigate for existing western portions of Roseville, the West Roseville Specific Plan (WRSP) area, and possible future annexation areas to the north and south of WRSP. Placer County is currently requiring retention mitigation be provided on a parcel-by-parcel basis within the large Sunset Industrial Park. It is recommended that a more regional approach to mitigating for the effects from Sunset Industrial Park be explored and that the County, similar to local City efforts, consider improved regional planning for urban development mitigation throughout the unincorporated areas of the watershed. It is also recommended that all local agencies consider and mitigate for impacts caused by new development over the range of channel forming events including the 2- to 10- and 100-year type events.

3.5.2 Channel Conditions

Channel conditions differ slightly between Pleasant Grove, Curry, and Kaseberg Creeks likely because of the current and historic land uses rather than natural geomorphic conditions. In general, the entire watershed is comprised of low gradient streams that had formed under intermittent flow conditions within the greater Sacramento River Valley floor. The fertile alluvial soils are excellent for farming, but have resulted in the channelization of many reaches within the watershed to assist with crop irrigation practices and prevent flooding of fields. This is especially true for the lower watershed, which historically has been and currently is impacted primarily by agricultural land uses.

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[3] (CH2M HILL, 1993 and 1994)

[4] (CH2M HILL, 1993 and 1994)

All of the creeks are incised or at least have reaches that show signs of down cutting and/or lateral cutting. This is due primarily to the increased drainage from impervious surfaces within the watershed that led to increased flow rates and decreased lag time (i.e. time to peak flow). In certain areas of the watershed, loss of riparian vegetation is exacerbating this situation. The down cutting of the stream bed has led to steep banks or bluffs surrounding the creeks that can reach up to 10 feet in height. Kaseberg Creek is the least incised of the major drainages within the watershed. As the drainage area increases the incision becomes more evident.

In urban areas of the upper watershed, storm drain outfalls have heavily impacted the local stream conditions and are the primary cause of incision and stream bank failure. Outfalls discharge directly into the creeks with some designs impacting the creeks more than others. The sudden increase of water volume and velocity associated with a storm drain outfall can cause a channel to down cut and widen in an attempt to reach a state of geomorphic equilibrium with its altered flows.

In the lower watershed, the installation of levees and channelization of the creeks is the primary cause of incision. Levees disconnect the stream channel from its floodplain, creating an efficient drainage or irrigation system but an ecologically dysfunctional stream. By preventing the creek from accessing the floodplain, water velocities increase, thereby increasing scour and promoting down cutting. Increased velocities also cause a decrease in a streams sinuosity and the levees prevent the stream meandering, both of which reduce the hydrologic and ecologic diversity present within the channel and adjacent riparian areas. It is recommended that as new projects are brought forward in the watershed, incision and bank stability surveys be required using a common rating method (i.e., Rosgen). These requirements will help establish current conditions, identify trouble areas, and document changes over time.

The creek bottoms are dominated by a muddy substrate with few fragmented riffles. Existing riffles in the upper watershed are dominated by small to medium sized gravels which increase in size to medium cobbles in the lower watershed. The riffles tend to be embedded 20% to 50% in the finer sediment present throughout the remainder of the creek channels.

As discussed in the previous section, improperly designed and under sized stream crossings, not only cause flooding but negatively impact the channel. Water backing up behind the crossing will drop out sediment which would otherwise be carried out of the watershed or deposited on the inside of bends or bars which have ecological value for riparian habitat. The flooding also saturates the surrounding soils and can cause instability in the banks which leads to sloughing and possible failure of the crossing. Poorly designed crossings can also lead to erosion and headcuts.

3.5.3 Water Quality

Background

Prior to any anthropogenic impacts upon the streams and their respective watersheds, the Pleasant Grove Creek system likely provided pristine habitat with excellent water quality. Only slight “impairments” due to natural processes would have been present, primarily stream forming geomorphic erosion and sedimentation, and annual flushing of nutrients stored in the soils built up by the decomposition of annual grasses during the summer and fall months.

Starting in the mid 1800’s, the Pleasant Grove Creek and Kaseberg Creek watersheds were used as rangeland by the local ranchers to raise sheep and cattle.[5] Water quality impacts would have been limited to the in stream uses of livestock, by defecating and urinating within the stream channel, and causing local sedimentation by trampling the stream banks. In the 1880s, when agriculture began to replace mining locally as the main industry, the nutrient rich alluvial soils were valued for more than gold, as they were used to grow wheat, raisin grapes, and oranges. Because crop lands comprise a small percentage of the total area within the watersheds, pesticides, herbicides, and salinity from irrigation return waters have not historically been a major issue of concern, but should be taken into consideration to prevent them from reaching concentrations that cause environmental impairment, similar to what has occurred in the San Joaquin Valley.

The urbanization of Roseville began in 1906 when the Southern Pacific Railroad moved its roundhouse and repair facilities from Rocklin to Roseville. The ensuing steady growth which has continued ever since has impacted the local stream water quality in several ways. Urban development increases the extent of impervious surfaces, which in turn increases storm water runoff and leads to increased erosion. Sediment in the streams hinder aquatic life and can carry toxics with it. Industries, such as the railroads and the historic Pacific Fruit Express ice plant, have brought with them industrial pollutants such as petroleum products and other semivolatile organic compounds (SVOCs) which may have found their way into the creek systems.

Monitoring Sites

Water quality samples were collected at five locations throughout the watershed to characterize existing conditions. Refer to the locations labeled PG1, PG3,

[5] (R.C. Fuller Associates, 1988)

PG5, K1, and C1 and in the Monitoring Site Location Map (Figure 3-8) and Table 3-3. Benthic Macroinvertebrate (BMI) samples were collected at PG1, PG2, K1 and C1. See Section 3.5.4 for details on the BMI study and results.

Table 3-3 Monitoring Site Descriptions

MONITORING SITE	CODE	LOCATION	CONTRIBUTION AREA AND REPRESENTATIVE LAND USE
Pleasant Gove Creek 1	PG1	On the main branch of Pleasant Grove Creek (PGC) between Foothills Boulevard and Industrial Avenue	Upper watershed and Rocklin; Urban
Pleasant Grove Creek 2	PG2	On the main branch of PGC at the downstream side of Crocker Ranch Road and upstream of the confluence of the South Branch of PGC (BMI Only)	Western Rocklin, and northern and eastern Roseville; Urban
Pleasant Grove Creek 3	PG3	On the main branch of PGC at the upstream side of Fiddyment Road at the confluence of the South Branch of PGC	Western Rocklin, and northern, eastern and central Roseville; Urban
Pleasant Grove Creek 4*	PG4	Downstream side of Brewer Road Bridge	NA-Non-accessible due to flooding and steep slopes
Pleasant Grove Creek 5	PG5	On Pleasant Grove Canal upstream of Howsley Road bridge	All Areas; Urban and Agricultural
S. Pleasant Grove Creek 1*	SPG1	Veterans Memorial Park	NA – lack of water and suitability for sampling
Kaseberg Creek 1	K1	On Kaseberg Creek at the downstream side of Sun City cart bridge north of Pleasant Grove Boulevard	Southern Roseville; Urban
Curry Creek 1	C1	On Curry Creek at the upstream side of the Pleasant Grove Road bridge	Southwestern watershed; Agriculture only

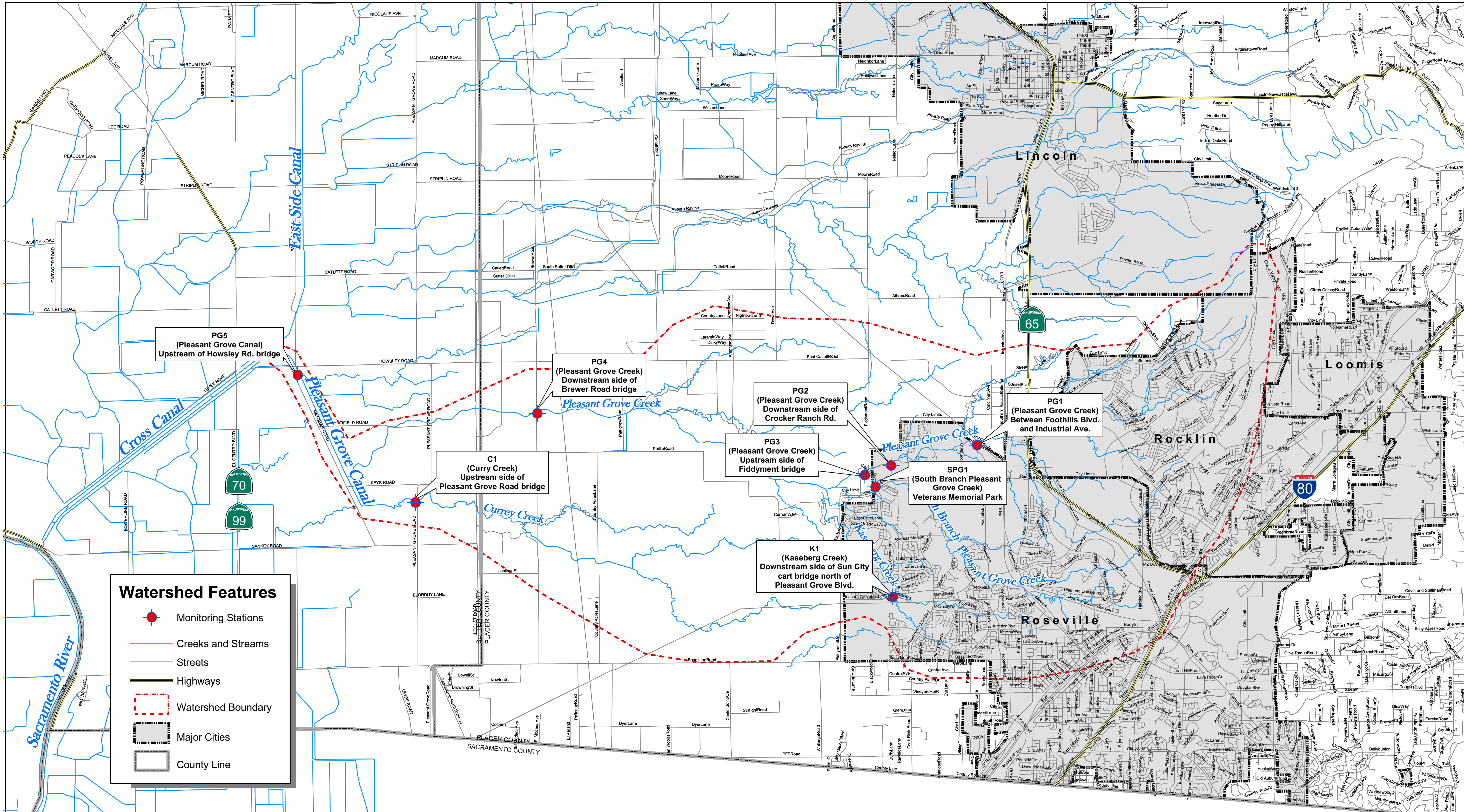
* No data collected from these sites due to lack of flow, unsuitable BMI habitat, and/or access limitations.

Monitoring Frequencies

Monitoring samples were collected quarterly in spring, summer, and fall (first flush) of 2004 and winter and spring of 2005. The winter 2005 samples were collected in February of 2005. Samples were collected for metals and organics in spring 2004, fall (first flush) 2004 and spring 2005. For exact sampling dates, please refer to the Laboratory Reports located in Appendix D. BMI samples were collected during spring of 2004 and 2005 during the two days immediately prior to the collection of the water quality samples.

Chemical Parameters

Samples collected at the locations disclosed above were analyzed for some or all of the 39 parameters selected for this monitoring program as dictated by the Quality Assurance Project Plan (QAPP) (Appendix G). The final list of parameters and sites were developed to maximize the amount of information obtained while staying within the project budget and access constraints. These parameters can be divided into seven different categories as shown in Table 3-4.



WATERSHED MONITORING MAP

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N

SCALE IN MILES
0 2

PLEASANT GROVE AND CURRY CREEKS

FIGURE 3-8

Table 3-4 Parameter List

Physical Characteristics	**Petroleum**	
Temperature	Oil and Grease	
pH	**Bacteria**	
Specific Conductance	Total coliform	
Total Dissolved Solids	E. coli	
Alkalinity	**Organics**	
Hardness	Organochlorine Herbicides	
Sediment	Organophosphate Pesticides	
Turbidity	Pesticides (including Glyphosate)	
Total Suspended Solids	**Metals (CAM 17[6])**	
Settleable Solids	Antimony	Lead
Biological Factors	Arsenic	Mercury
Nitrate	Barium	Molybdenum
Nitrite	Berylium	Nickel
Ammonia	Cadmium	Selenium
Phosphate	Chromium	Silver
Biological Oxygen Demand	Cobalt	Thallium
Dissolved Oxygen	Copper	Vanadium
	Zinc	

Temperature is an important parameter for several reasons and is monitored to help provide insight into the overall condition of the stream. There are three main impacts temperature has on a streams health and water quality. First is a tolerance of some species to survive varying temperature ranges or fluctuations. Secondly, many biological reactions, including those involved with decomposition and respirations, are temperature dependent. And third, water's ability to dissolve gases, primarily oxygen, is dictated by temperature (see Dissolved Oxygen for more details).

pH is the measurement of the stream's acidity. Pure water has a neutral pH of 7.0, or a balance between free hydrogen ions (H^+) and free hydroxyl ions (OH^-). Conditions below neutral are considered to be acidic and have more hydrogen than hydroxyl ions. Conditions above neutral are considered to be basic and have more hydroxyl than hydrogen ions. According to the CVRWQCB Basin

[6] Title 22, California Code of Regulations

Plan[7], pH is to remain between 6.5 and 8.5. This range is based upon values that are healthy for most aquatic organisms.

Specific Conductance (SC) is a measure of the ability for water to conduct or pass electricity. SC increases with increases in temperature and ion concentrations or TDS. However, because different ions have unique electrical properties and varying contributions to SC there is no direct relationship between SC and TDS. SC is either measured at a standard 25°C or is temperature corrected to 25°C. Ultimately, SC provides a cheap and easy field technique for determining changes in a streams total ionic concentration. SC should remain under 1,600 μs/cm according to CCR Title 22.

Total Dissolved Solids (TDS) is a direct measurement of all particles that are dissolved (<0.05 μm in size). Water is filtered through a 0.05 μm filter and then evaporated. What remains are the dissolved solids. TDS is also used to check the completeness of the water quality analysis. Adding up the concentrations of all analyzed parameters should equal the measured TDS. A certain amount of error should be expected, typically ±5% in a controlled laboratory setting and ±20%-30% in a natural environment. TDS should remain below 1,000 mg/L according to CDHS Drinking Water Standards.

Alkalinity is a measure of the acid neutralizing ability of water, specifically the sum of all titratable bases. The primarily source in surface waters comes from hydroxide, carbonate and bicarbonate although other bases do have an affect to a lesser extent[8]. Because testing for alkalinity provides a measurement for the major cations, it is useful in performing the TDS completeness checks.

Hardness is a measure of the divalent cation concentration, or those ions which have a 2+ charge. In natural waters this is primarily attributed to magnesium (Mg^{2+}) and calcium (Ca^{2+}) which are two of the most abundant minerals in the earth's crust. Typically increases in hardness indicate water that has spent more time in contact with soil, i.e. as ground water. Hardness is also a factor in metal toxicity, where increases in hardness cause reductions in toxicity, allowing greater concentrations of the metal to be less toxic. Hardness can be qualitatively observed by lathering soap in water. "Hard" water with higher concentrations of calcium and magnesium will hinder or prevent a good lather from ever developing, however "soft" water with low concentrations of divalent cations produces a good lather but does not rinse the soap away leaving a residue.

[7] Central Valley Regional Water Quality Control Board, Water Quality Control Plan (Basin Plan) (1998)
[8] Clesceri *et. al.* 1998

Turbidity is a measure of the ability for light to pass through water. It is used as an easy and indirect measurement of suspended material, often times mistaken to be a direct measurement of sediment. No direct physical relationship exists between turbidity and TSS, although general site specific relationships can often be derived.

Total Suspended Solids (TSS) is a direct measurement of the suspended material (>0.05 μm) in the water. Water is filtered through a 0.05 μm filter and then dried. By subtracting the previously measured mass of the filter from the total mass of the filter and solids, the mass of solids can be calculated. TSS is often associated with sediment, and usually increases with increased stream velocities such as during storm events which provide the energy needed to pick up and suspend small particles. Depending upon the size, particles can remain in suspension for hours up to months due to the insipient energy derived by intermolecular movement.

Settleable Solids is a measurement of the volume of sediment in the water column which, when undisturbed, settles out within an hour. As with TSS, settleable solids is often associated with sediment, and usually increases with increased stream velocities such as during storm events which provide the energy needed to suspend larger particles.

Nitrate Nitrogen (NO_3-N) is the primary form of mineral nitrogen, which is the total available nitrogen for plant uptake. Nitrate (NO_3^-) which is not incorporated into organic matter either is converted back into nitrogen gas (N_2) through the denitrification process or is leached past the rooting zone into the groundwater or surface water. Nitrate is often the limiting growth nutrient for terrestrial systems. Nitrate as nitrogen should remain below 10 mg/L according to CDHS Drinking Water Standards[9].

Nitrite Nitrogen (NO_2-N) is a minor occurring form of nitrogen in surface waters that is an intermediary step in the nitrification process which converts ammonium (NH_4^+) to nitrite (NO_2^-) and then to nitrate (NO_3^-) through an oxidation reaction. The sum of nitrate plus nitrite represents mineral nitrogen which is the total available nitrogen for plant uptake[10,11].

Ammonia Nitrogen (NH_3-N) is formed through the deamination process which is the breaking down of organic nitrogen molecules such as proteins and nucleic acids. Ammonia (NH_3) is also the initial form of nitrogen that has been fixed from atmospheric nitrogen gas. Ammonium (NH_4^+), the ionized form of

[9] CDHS Drinking Water Standards.

[10] Clesceri *et. al.*, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed.. American Public Health Association, American Water Works Association, Water Environment Federation.

[11] Snoeyink and Jenkins, 1980. Water Chemistry. John Wiley & Sons, Inc.

ammonia, is naturally present in an acid-base equilibrium with ammonia and is the initial form of nitrogen used in the nitrification process which results in nitrate. Organic nitrogen can be calculated by subtracting ammonia from Total Kjeldahl Nitrogen (TKN)[12].

Phosphate Phosphorus (PO_4-P) is the dominant and often sole form of phosphorus in natural waters. Phosphorus in general is highly immobile because of its low solubility, which is why phosphate ion (PO_4^{3-}) is the only form found in natural waters. Phosphorus is an essential nutrient for the growth of biological organism and is often times the limiting nutrient for aquatic systems[13]. Because of this, increases of phosphate in surface waters typically indicate a potential for algal growth and possible stream eutrophication.

Biological Oxygen Demand (BOD_5) is a measure of the relative amount of oxygen needed to decompose the organic matter present in a 5-day period. BOD_5 includes oxygen used for the decomposition of organic material (carbonaceous demand, CBOD), oxidization of some inorganic material (i.e. sulfides and ferrous iron) and the nitrification of ammonia (nitrogenous demand)[14]. Subtracting the amount of oxygen used to nitrify ammonia results in $CBOD_5$, the oxygen used only for organic matter decomposition.

Dissolved Oxygen (DO) is a measurement of the amount of oxygen dissolved in the water. DO is what fish and other aquatic organisms use as their oxygen source for respiration. DO concentrations are affected by water temperature and mixing. Cooler water can dissolve more oxygen, while mixing water increases the contact surface area between oxygen depleted water and atmospheric oxygen allowing for increases in DO concentrations. DO concentrations should remain above 7 mg/L in a cold water fishery water body, and above 5 mg/L in a warm water fishery water body[15] to protect the health of the fish within the system. Decreases in DO are often times associated with the decomposition of excessive organic matter, and can decrease to anoxic (low oxygen content) conditions if mixing is not present. This is often times associated with elevated BOD concentrations.

Oil and grease is a relative measurement of petroleum hydrocarbons and fatty matter from animal and vegetable sources[16]. It is assumed in non-wastewater environments that the fatty matter component is negligible and the oil and

[12] Clesceri *et. al.*, 1998
[13] Clesceri *et. al.*, 1998
[14] Clesceri *et. al.*, 1998
[15] Central Valley Regional Water Quality Control Board, Water Quality Control Plan (Basin Plan) (1998)
[16] Clesceri *et. al.*, 1998.

grease measurement is more a general measurement of automotive derived hydrocarbon pollutants (i.e. gasoline, diesel, oil, etc.).

Total coliform is a statistical measurement of the total number of bacteria likely present. This includes both fecal coliform and other natural occurring bacteria such as those associated with the decomposition of organic material. There are obvious health concerns associated with elevated numbers of total coliform.

E. coli is sometimes used as a surrogate for fecal coliform, which is bacteria found in feces, because it is the most common fecal species. *E. coli* and fecal coliform cause many diseases and are a health concern. The CVRWQCB's Basin Plan allows up to 10 percent of the total number of samples taken during any 30-day period to exceed 400MPN/100ml[17].

Organics is a general term for herbicides and pesticides because they are considered organic molecules, having carbon chain bases and comprised primarily of hydrogen, oxygen and some other compound such as phosphate or chlorine. This monitoring project tested for three groups or suites of organics; organochlorine herbicides, organophosphate pesticides, and a more generic set of pesticides including glyphosate (sold as Round-Up). Any detection of these chemicals typically indicates either a spill or general over application of the chemical (i.e. non-point source pollution).

Metals are can become toxic at low levels, with toxicity varying based upon hardness of the water. Other metals, like mercury, will bioaccumulate or biomagnify, resulting in increased tissue concentrations higher up in the food web making the consumption of such foods hazardous to human health. Title 22 of the California Code of Regulations outlines primary and secondary Maximum Contaminant Levels (MCLs) for priority pollutants, including those metals of concern.

[17] Central Valley Regional Water Quality Control Board, Water Quality Control Plan (Basin Plan) (1998)

Water Quality Criteria

For many water quality parameters, various criteria have been developed either as regulations[18,19] or to provide guidance for the protection of human or environmental health.[20,21] Not all of the above-mentioned parameters have water quality criteria or water quality objectives. Of the existing criteria and objectives, some are variable and some have more than one value[22]. When appropriate, the data tables show the applicable criteria or water quality objective. Many of the metals have criteria that are based on hardness. Those samples, if any, which have concentrations that do not meet the criteria based on the metal concentration and hardness will be noted and discussed later in this section.

Chemical Monitoring Analysis

The chemical water quality results are presented in the next section by parameter in tables and graphs. As described above, applicable water quality criteria are shown when available. Where results are non detectable, the results are reported as less that the reporting limit, e.g. <5.0, where 5.0 is the lowest concentration that the lab can accurately report while staying within its California certification requirements.

Where appropriate, graphs of the data are included to help illustrate the results. A combination of line and modified box-n-whisker plots[23] (Figure 3-9) are used. A box-n-whisker plot is a way of showing statistical information about the data set. The top part of the box represents the 75th percentile, or 75% of the data is less than or equal to this value. The line running through the middle of the box represents the median, and the bottom of the box represents the 25th percentile, where 25% of the data is less than or equal to the value. The whiskers represent the maximum and minimum values, and the diamond represents the mean or average of the data set. Limited data was collected and used in this analysis so only preliminary conclusions should be drawn from this study.

[18] 40 CFR Part 131, California Toxics Rule

[19] California Code of Regulations, Title 22

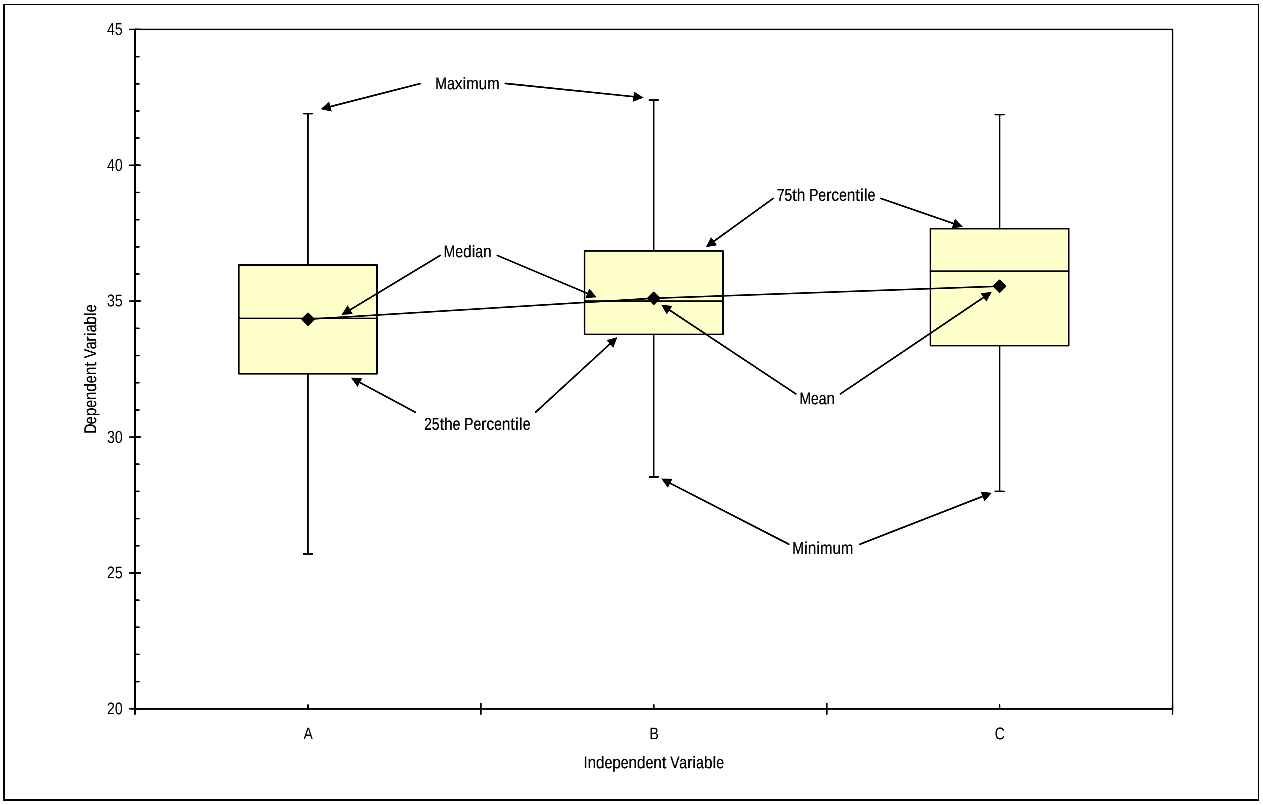
[20] The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

[21] A Compilation of Water Quality Goals, August 2003.

[22] 40 CFR Part 131, California Toxics Rule

[23] Helsel, DR and RM Hirsch, 2002. Statistical Methods in Water Resources, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 4, Chapter A3.

Figure 3-9 Example box-n-whisker plot



Temporal and spatial representative graphs are used in this analysis to investigate relationships within the watershed. A graph showing temporal relationships looks at changes throughout time by setting the independent variable (x-axis) as sampling date and plotting site data on the graph. A graph showing spatial relationships looks at changes throughout the watershed during a particular instant in time by setting sampling sites as the independent variable then plotting the data accordingly. Each of these graph types help to illustrate different relationships that exist within the watershed.

Results and Discussion

The temperature results show an annual or seasonal cyclic pattern with summer temperatures ranging from 20.8 °C to 25.0 °C and winter temperatures from 11.6 °C to 13.7 °C (Table 3-5). None of the sites met the 20 °C objective set forth by the Basin Plan[24] during the summer sampling event (Figure 3-10). C1 tended to be slightly cooler than the rest of the system. Because Curry Creek is an agriculturally dominated system, possible causes for these decreased temperatures are minimal impervious surfaces resulting in more groundwater

[24] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

recharge of the creek or irrigation return waters. Also evident is a slight increasing trend in temperatures from the upper to lower watershed which can be seen in Figure 3-11. This is likely due to the widening of the stream bed caused by development in the upper watershed, eroding away riparian areas that provide shade and increasing the surface to depth ratios allowing solar radiation to have more of an affect on creek temperatures.

The stream pH averaged 7.3 with a high of 8.6 at C1 in spring 2005 and a low of 6.1 at K1 in winter 2005 (Table 3-6). Excluding these two readings, the remainder fell within the 6.5 to 8.5 range set in the Basin Plan[25]. The increased pH at C1 may have been caused by an increase in aquatic vegetation and a lack of spring flows resulting in a stripping of the acids out of the water column by oxygen produced during photosynthesis. K1 was consistently lower than the other sites with an average pH of 6.9, just below neutral, but had a low of 6.1.

Specific conductance stayed well below the 1,600 μs/cm limit set by the Department of Health Services (DHS) in Title 22[26] with an average of 342 μs/cm (Table 3-7). A dilution of the creek water appears to be occurring during the winter; however PG5 remained high (Figure 3-14) likely do to storm waters backing up in the Cross Canal from the Sacramento River. Specific conductance trends closely mimicked TDS trends with K1 being consistently low, having an average of 151 μs/cm (Figure 3-15), almost half that of the watershed average.

As with the specific conductance, TDS results were well below the 1,000 mg/L criteria set by Title 22 (Table 3-8). An average of 225 mg/L were recorded for the watershed with a maximum of 390 mg/L and a minimum of 96 mg/L. Winter dilution does not appear to be a factor with TDS, as was observed with specific conductance, but K1 was consistently low with an average of 122 mg/L (Figure 3-17) throughout the study.

All alkalinity values for this study were above the 20 mg/L as $CaCO_3$ minimum objective as set forth by the CVRWQCB[27]. A slight dilution may be occurring during the winter (Figure 3-18) with an average alkalinity of 68 mg/L. Once again, K1 stands out as having a consistently lower alkalinity with an average of 55 mg/L $CaCO_3$ (Figure 3-19). This also corresponds to the lower pH observed at the site since the carbonate system is so closely tied to the pH of surface waters.

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[25] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

[26] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15 Article 16, Section 65559

[27] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

The samples were analyzed for hardness two times, mainly for use with identifying metal toxicity. The first flush had the greatest range with a maximum of 220 mg/L at PG1 and a minimum of 50 mg/L $CaCO_3$ at PG3. The spring 2005 remained more constant with hardness ranging between 94 and 160 mg/L $CaCO_3$.

Sediment

Turbidity stayed below 60 NTUs for this study except at C1 in spring 2004 which was 450 NTUs (Table 3-11). This single event is likely due to some activity up stream, perhaps the flushing of an irrigation line or draining of a field. Water with turbidities less than 30 NTUs, which represent the majority of the samples collected, typically look pristine, while 60 NTUs visually do not appear to contain much sediment and is a reasonable value to expect in a muddy bottom stream. Interestingly, little variation occurred between the sampling events, even during storm flows, but a slight increase did appear between the upper and lower watershed with averages of 11, 16 and 26 NTUs moving down stream from sites PG1, PG3 and PG5 respectively (Figure 3-22). This would indicate that the source of turbidity increases further down the watershed.

Similar to the turbidity results, the C1 spring 2004 concentration of 210 mg/L TSS is almost twice as much as any other result, with the majority remaining below 60 mg/L and an average of 40 mg/L (Table 3-12). TSS remained fairly constant throughout time, excluding the C1 Spring 2005 sample. A slight possible increase during storm events (first flush and winter) may be occurring but more monitoring will be needed to confirm this hypothesis. The similarities between turbidity and TSS can be seen when comparing the trends observed in the temporal analysis (Figure 3-21 and Figure 3-23) and the spatial analysis (Figure 3-22 and Figure 3-24).

Only the first flush sampling event had enough energy to suspend and transport measurable amounts of settleable solids (Table 3-13). The tributaries had the greatest concentrations with K1 being the highest at 55 mg/L and C1 at 22 mg/L. PG1, PG3, and PG5 were all very similar with results ranging between 7.3 and 12 mg/L. No spatial trend is evident based upon the data collected by this study (Figure 3-25).

Biological Factors

Nitrate nitrogen was not detected during the sampling events in spring and summer of 2004. All detected values were well below the 10 mg/L upper criteria limit set by DHS in Title 22[28]. Spikes of nitrate were recorded at PG5 in winter 2005 and at C1 in spring 2005. All other samples remained below 0.5

[28] Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.

mg/L. Concentrations did not increase during the first flush event, but the winter samples had the highest average concentration of 0.6 mg/L. This is opposite of what is usually expected with first flush having the greatest concentrations, but suggests that the nitrogen sources within the watershed take longer to reach the stream than what the first flush allowed. Non detectable summer concentrations are likely due to uptake by aquatic vegetation and algae.

Nitrite nitrogen was only detected once during this study, during the spring 2005 sampling event in the main stem Pleasant Grove Creek. Concentrations increased from 0.29 mg/L at PG1 in the upper watershed to 0.62 mg/L at PG5 in the lower watershed (Figure 3-28) suggesting that either the nitrogen source increased down stream, or that nitrification process was more active in the upper watershed. The tributaries, K1 and C1 did not have detectable levels of nitrite. Nitrite nitrogen remained well below the 1.0 mg/L upper criteria set by DHS and Title 22[29].

The only time ammonia nitrogen was not detected was during the summer 2004 sampling event (Table 3-16 and Figure 3-29). The concentrations at C1, with an average of 0.4 mg/L, were higher than at any of the other sites which averaged at or less than 0.2 mg/L (Figure 3-30). Ammonia is the primary form of nitrogen used in fertilizers, which would suggest that elevated spring concentrations at C1 are likely due to the fertilizing of newly planted crops.

Phosphate phosphorus was not detected in any of the samples taken throughout the study. This indicates that the watershed creek system is phosphorus limited, as is typical with most aquatic systems. If the reporting limit for phosphate phosphorus could be lowered to 0.1 mg/L or less it would help to confirm this hypothesis. However, continued monitoring will be needed to better understand the general nutrient cycling within the watershed.

Detectable levels of BOD were only found during two sampling events at K1 and C1, and one event at PG1. All three of these sites had BOD during the spring 2005 sampling with an average of 7.3 mg/L O_2. BOD was not detectable at PG3 or PG5. Typically elevated levels of BOD can be correlated to decreased DO concentrations due to eutrophic conditions and increased turbidity if caused by detached floating algae. However, the limited data used in this analysis does not show either of these relationships.

DO ranged between 1.9 and 9.6 mg/L O_2. An annual cycle is evident, with low DO values in the summer and higher values in the winter. Summer values are primarily below the 5.0 mg/L criteria set in the Basin Plan[30] except for at PG3

[29] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.

[30] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

with 7.0 mg/L which is just downstream of the confluence with South Branch Pleasant Grove Creek. C1 had lower values than the other sites with an average of 5.2 mg/L, 1.1 mg/L below the watershed average. This could be partially due to the fact that few, if any, riffles exist within Curry Creek which are instrumental in mixing the creek water and increasing DO concentrations. Low flows, resulting in stagnation, and increased water temperatures both contributed to the generally low DO of the watershed during the summer months.

Petroleum

There were only two hits with detectable levels of oil and grease which occurred in spring 2005 at K1 and PG3 with 790 and 55 mg/L, respectively. Both of these sites receive runoff from the middle of the watershed including western Roseville, suggesting that there may be a local source of petroleum contamination such as a diesel leak at a construction site. Further investigations should be conducted to determine if this had developed into a persistent problem and location of the source.

Bacteria

The first flush response for total coliform reached the upper reporting limit (1,600 MPN/100ml) for the 2x5 method originally used by this study (Table 3-21). Because of this it is hard to know exactly how high the coliform counts were, but the winter 2005 results had an average of 29,928 and a maximum of 90,000MPN/100mL which provides a general order of magnitude as to what could be expected. K1 had consistently high coliform counts ranging from 1,700 to 50,000 MPN/100mL. PG1, C1 also had higher average counts (17,363and 3,226 MPN/100ml averages respectively) than did PG3 or PG 5 (878 and 1,077 MPN/100ml averages respectively). PG1 and K1 are both located downstream of beaver dams which are likely a major source of the coliform present in both samples. C1 is down stream of some wide, slow moving sections of the creek with thick emergent macrophyte vegetation that provides excellent habitat for water fowl, another likely major source of the observed coliform.

E. coli was not detected during the spring 2004 sampling event, and only K1 exceeded the upper reporting limit of 1,600 MPN/100mL during the first flush. As with total coliform, PG1, K1 and C1 (967, 17,200 and 590 MPN/100ml averages respectively) were considerably higher then PG3 and PG5 (243 and 267 MPN/100ml averages respectively). Assuming that *E. coli* is a true surrogate for fecal coliform, which has an upper criteria of 400 MPN/100mL[31]

[31] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

(Table 3-22), then most of the sites within the watershed are likely in violation. However, this criteria is for waters intended to support contact recreation (i.e. not the Pleasant Grove system), and the results obtained from this study are not unreasonable for a small creek which is inhabited by larger animals such as beavers, ducks, and geese. Even though the high concentrations of coliform are naturally generated and not directly caused by human activities, they still pose some health risk to individuals that come into contact with the water. Public signage or other outreach may need to be considered to educate local residences as to the possible health risks.

Organics

All of the organochlorine herbicides analyzed for were undetectable except for 2,4-d during the spring 2005 sampling where results of 0.68, 0.58 and 0.07 μg/L were detected (Table 3-23). 2,4-D is the third most widely used herbicide in the United States[32], so the presence of it in the watershed is not unexpected. It is important to note that the concentrations detected are less than a hundredth of the 70 μg/L criteria set by DHS in Title 22[33]. None of the organophosphate (Table 3-24) or general pesticides (Table 3-25) analyzed for were present at detectable concentrations.

Metals

Detectable concentration of arsenic, barium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, silver and vanadium were found in at least some of the samples (Table 3-26). However, all detectable concentrations of metals were one tenth, if not less, of their designated criteria. Cadmium and Thallium have reporting limits that are greater than some of their water quality goals (Table 3-26) which creates the possibility that concentrations may actually exceed that goal. In addition, when taking hardness into account, none of the metals meet or exceed any of the toxicity levels set forth by the California Toxics Rule[34]. While mercury and other metals do not appear to be present in concentrations that negatively impair water quality, sediments should be tested to confirm that metal adsorption has not occurred and they are being not stored in the bed load sediment and detritus.

[32] Industry Task Force II on 2,4-D Research Data (www.24d.org).

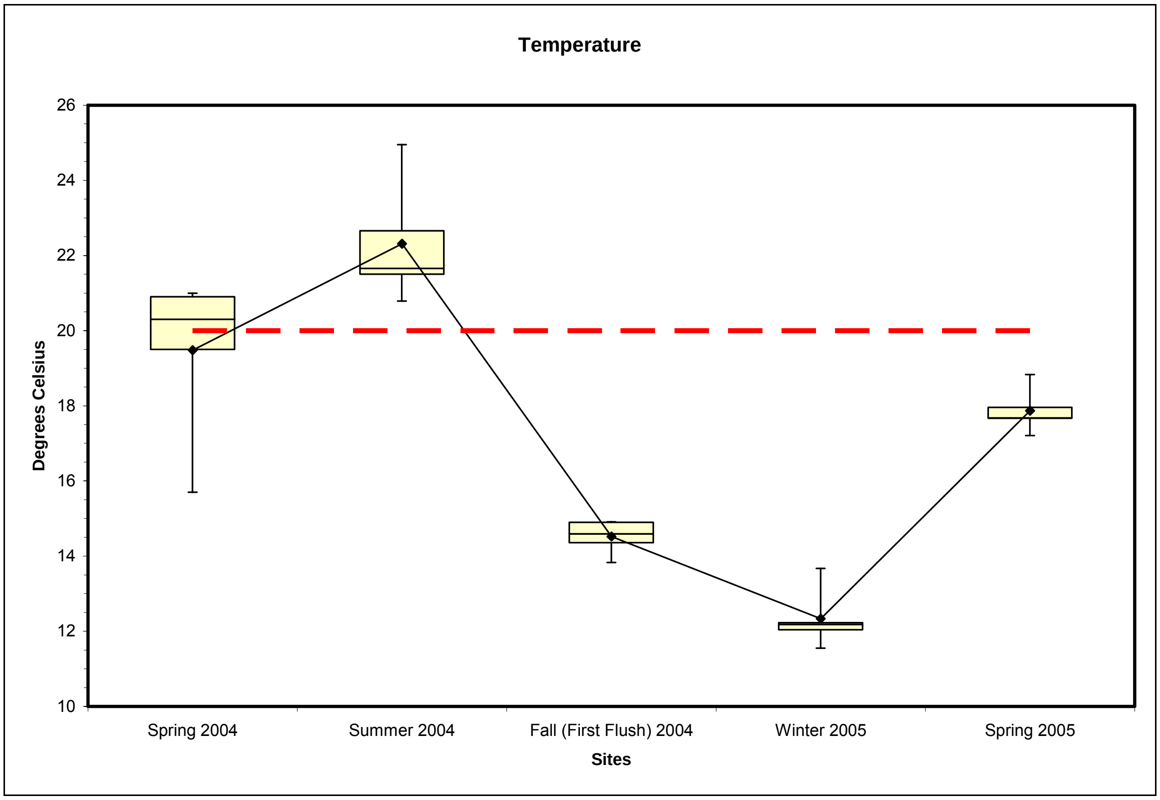
[33] Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 5.5 Section 64444.

[34] Environmental Protection Agency, 40 CFR Part 131 “California Toxics Rule (CTR)”.

Table 3-5 Stream Temperature Results

Temperature	Units	K1	C1	PG1	PG3	PG5	Criteria[35]
Spring 2004	°C	20.9	15.7	21.0	19.5	20.3	20
Summer 2004	°C	20.8	21.5	21.7	22.7	25.0	20
Fall (First Flush) 2004	°C	14.4	13.8	14.6	14.9	14.9	20
Winter 2005	°C	12.0	11.6	12.2	12.2	13.7	20
Spring 2005	°C	17.2	17.7	18.0	17.7	18.8	20

Figure 3-10 Stream Temperature Temporal Analysis Graph



[35] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-11 Stream Temperature Spatial Analysis Graph

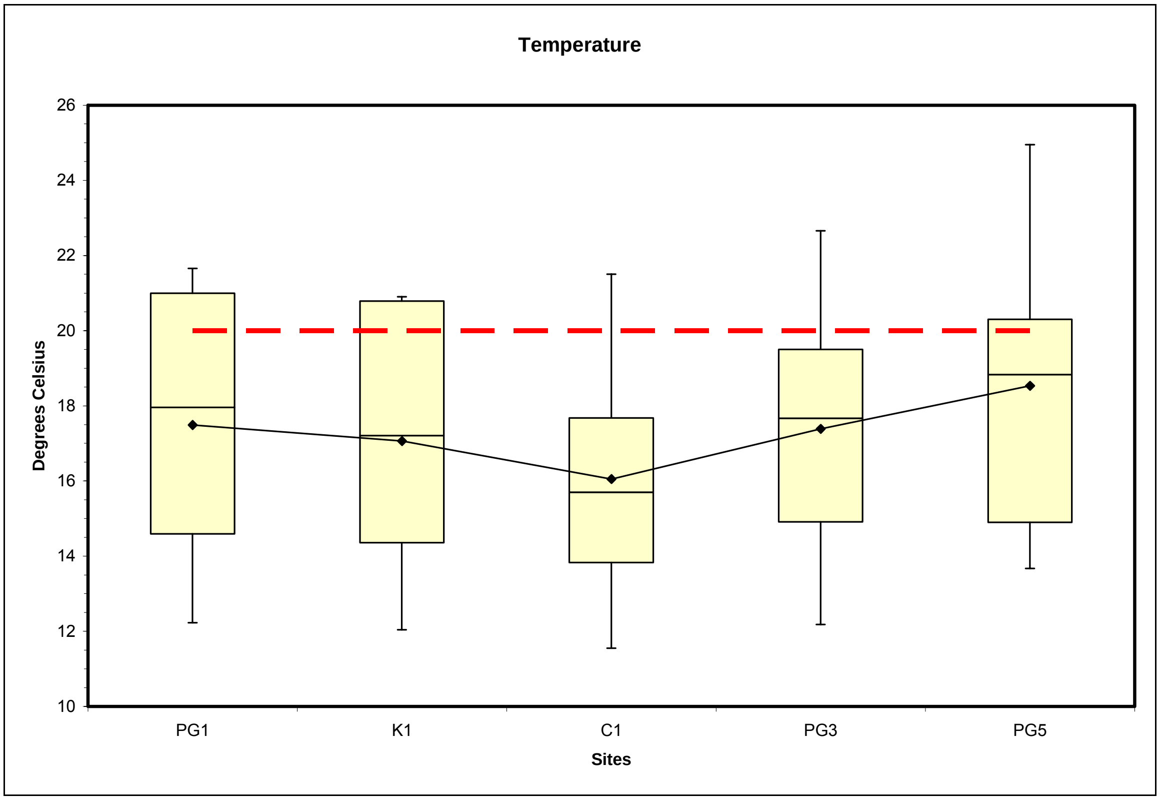


Table 3-6 pH Results

pH	Units	K1	C1	PG1	PG3	PG5	Criteria[36]
Spring 2004	pH Units	7.4	7.3	7.9	8.0	7.3	6.5-8.5
Summer 2004	pH Units	6.7	7.3	7.6	7.8	6.9	6.5-8.5
Fall (First Flush) 2004	pH Units	7.2	7.6	7.6	7.1	7.5	6.5-8.5
Winter 2005	pH Units	6.1	6.9	6.6	6.8	7.3	6.5-8.5
Spring 2005	pH Units	7.0	8.6	7.4	7.6	6.9	6.5-8.5

[36] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-12 pH Temporal Analysis Graph

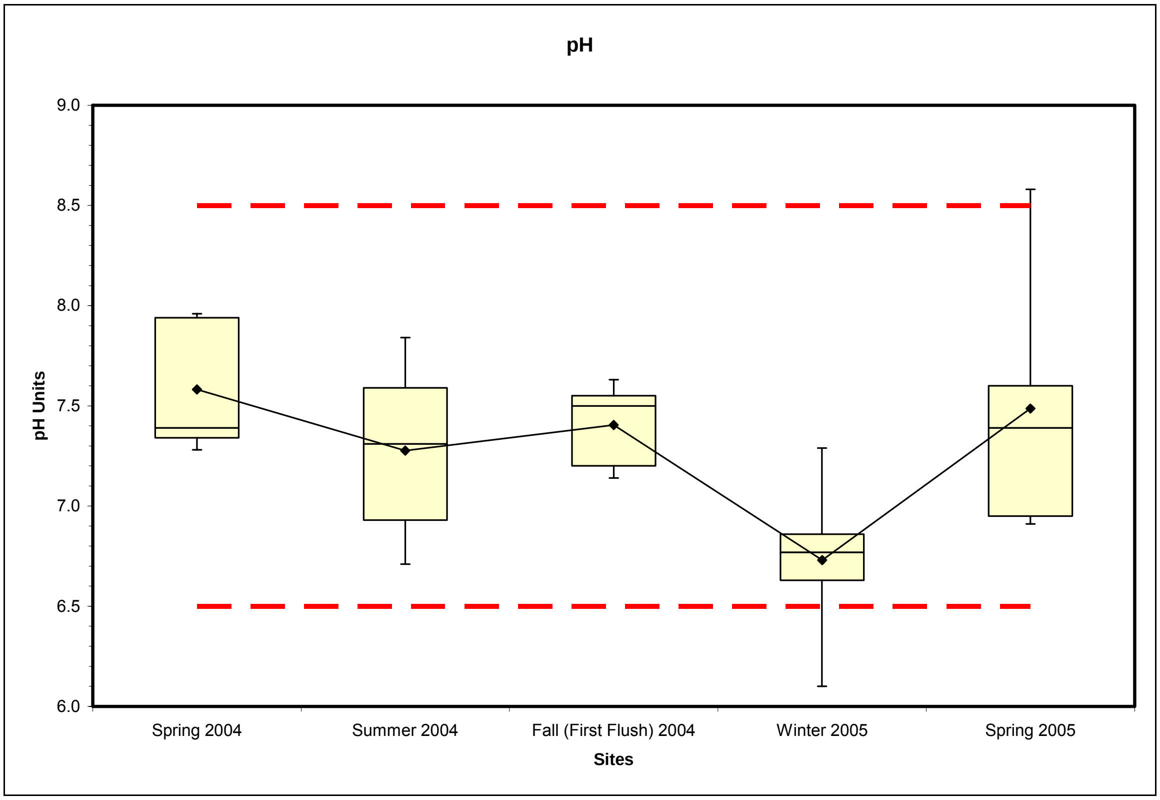


Figure 3-13 pH Spatial Analysis Graph

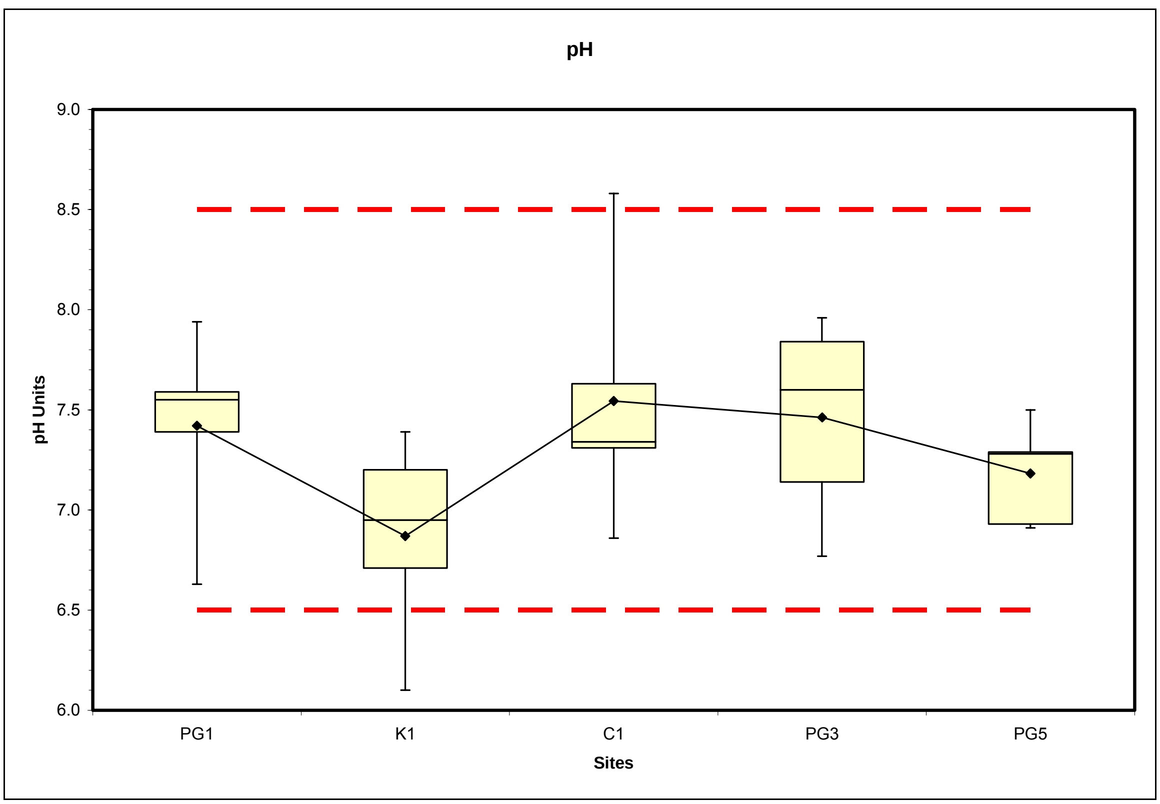
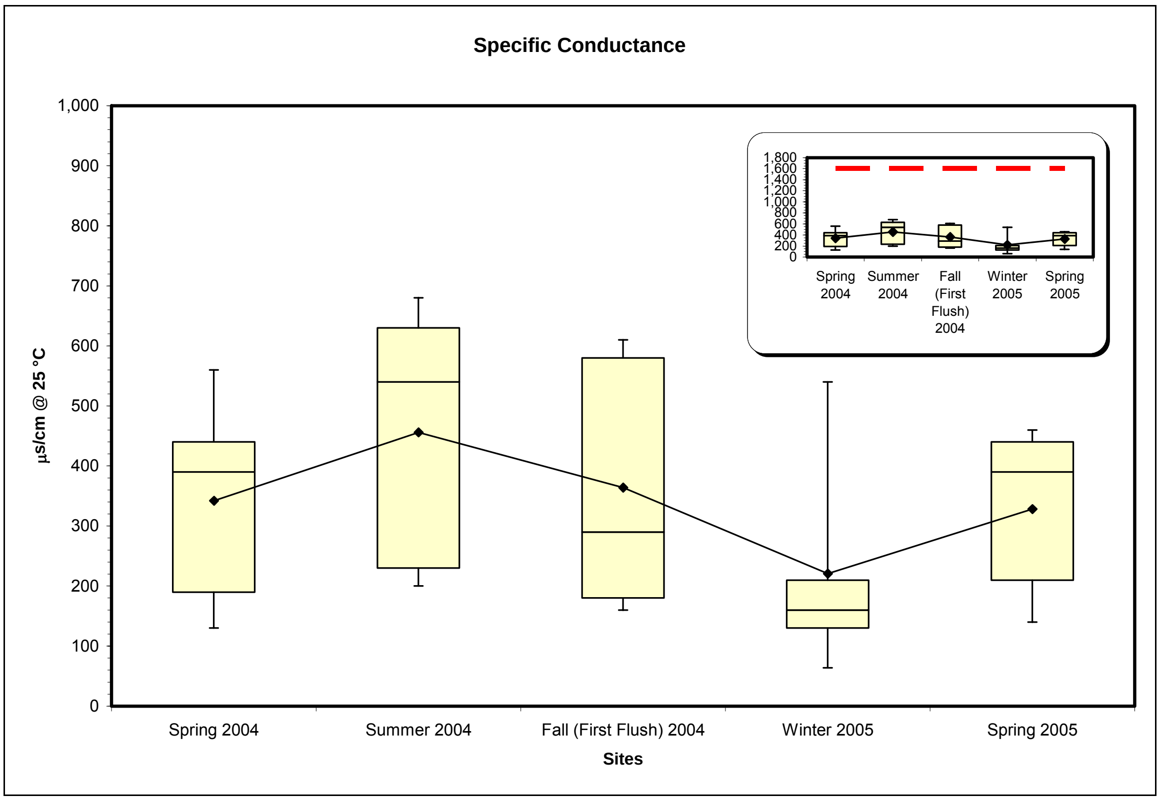


Table 3-7 Specific Conductance Results

Specific Conductance	Units	K1	C1	PG1	PG3	PG5	Criteria[37]
Spring 2004	µS/cm	190	440	560	390	130	1,600
Summer 2004	µS/cm	200	630	680	540	230	1,600
Fall (First Flush) 2004	µS/cm	160	610	580	180	290	1,600
Winter 2005	µS/cm	64	210	160	130	540	1,600
Spring 2005	µS/cm	140	210	440	390	460	1,600

Figure 3-14 Specific Conductance Temporal Analysis Graph



[37] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15 Article 16, Section 65559.

Figure 3-15 Specific Conductance Spatial Analysis Graph

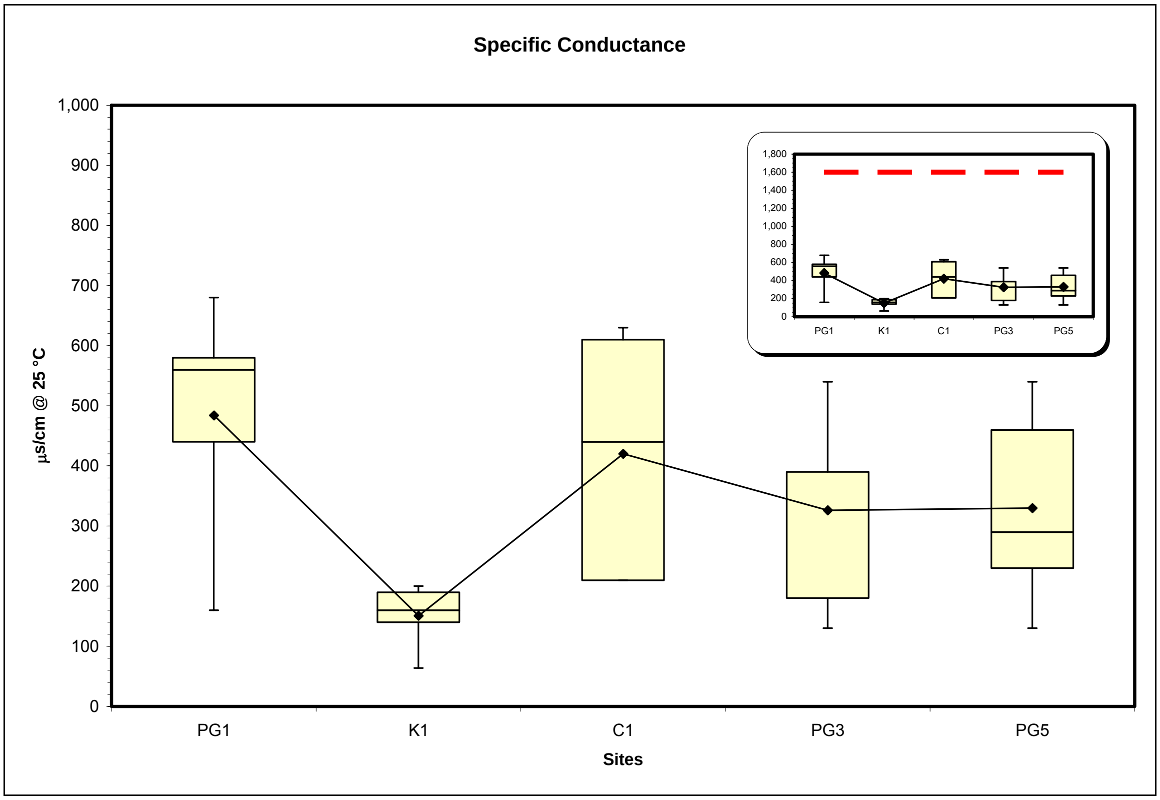


Table 3-8 Total Dissolved Solids (TDS) Results

Total Dissolved Solids	Units	K1	C1	PG1	PG3	PG5	Criteria[38]
Spring 2004	mg/L	140	380	380	250	110	1000
Summer 2004	mg/L	120	330	360	310	120	1000
Fall (First Flush) 2004	mg/L	120	290	300	160	96	1000
Winter 2005	mg/L	120	230	160	150	390	1000
Spring 2005	mg/L	110	190	270	260	270	1000

[38] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15 Article 16, Section 65559.

Figure 3-16 TDS Temporal Analysis Graph

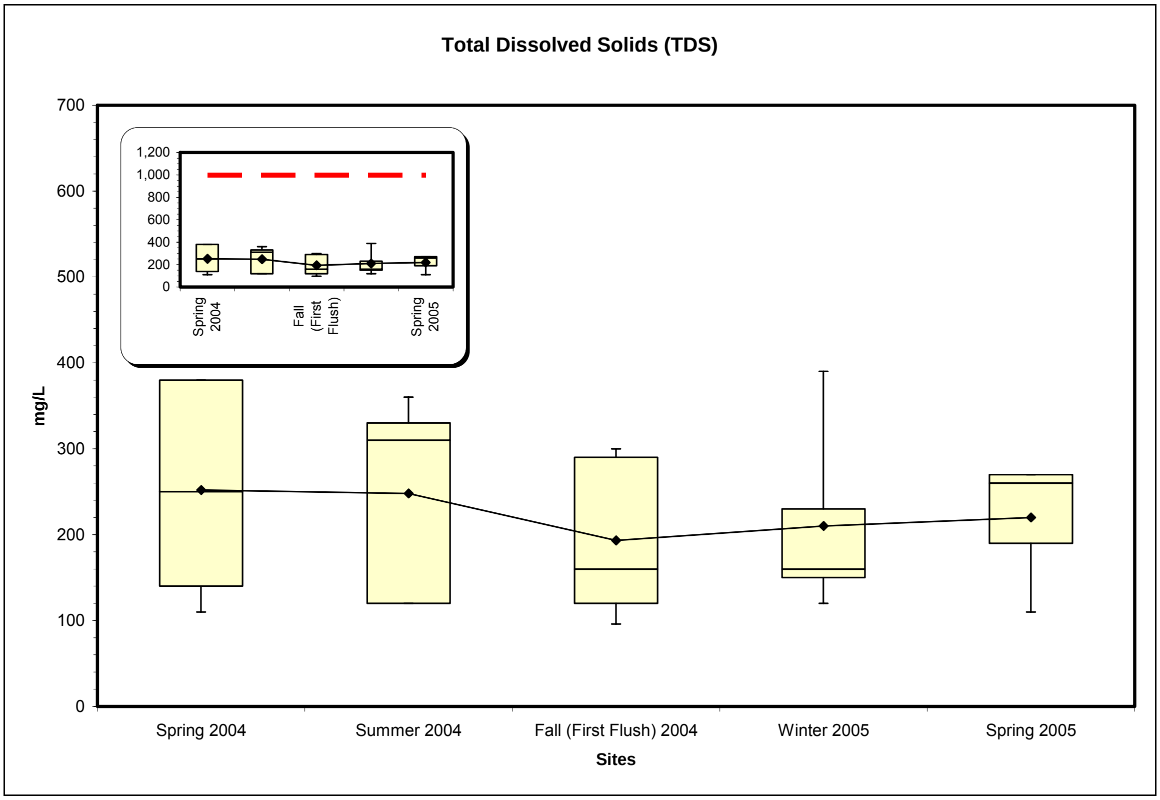


Figure 3-17 TDS Spatial Analysis Graph

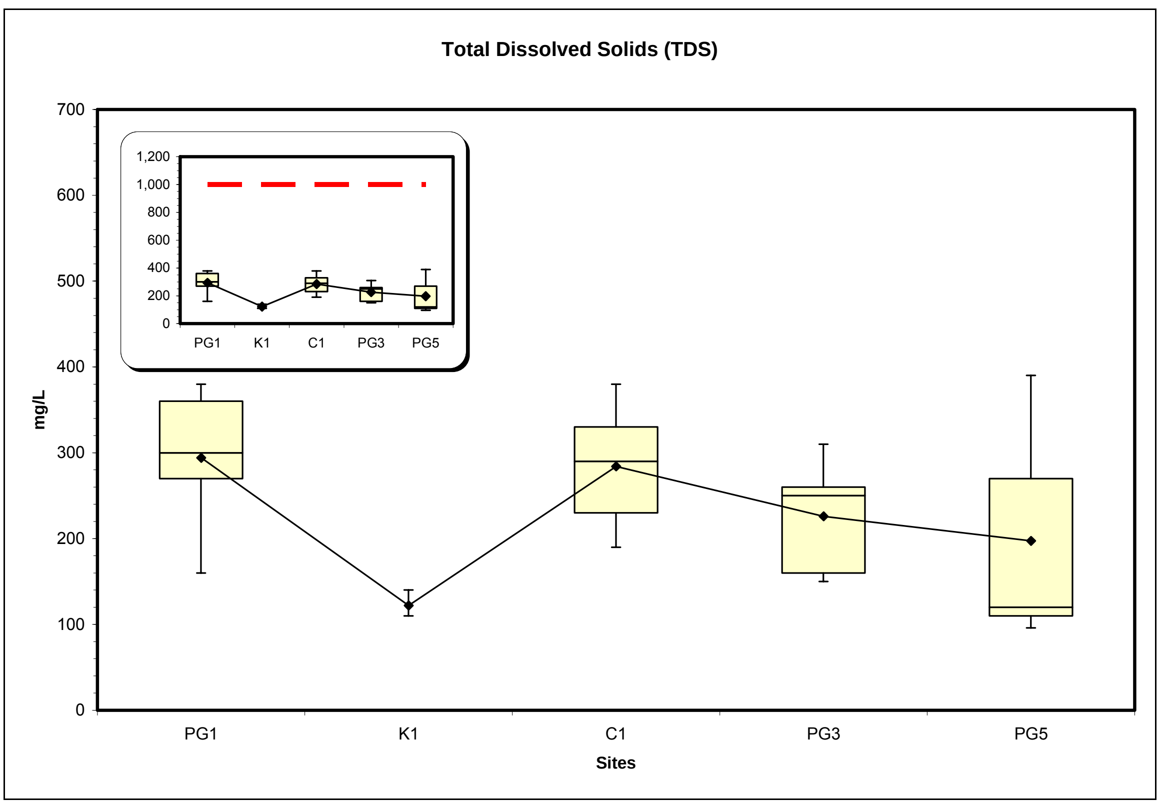


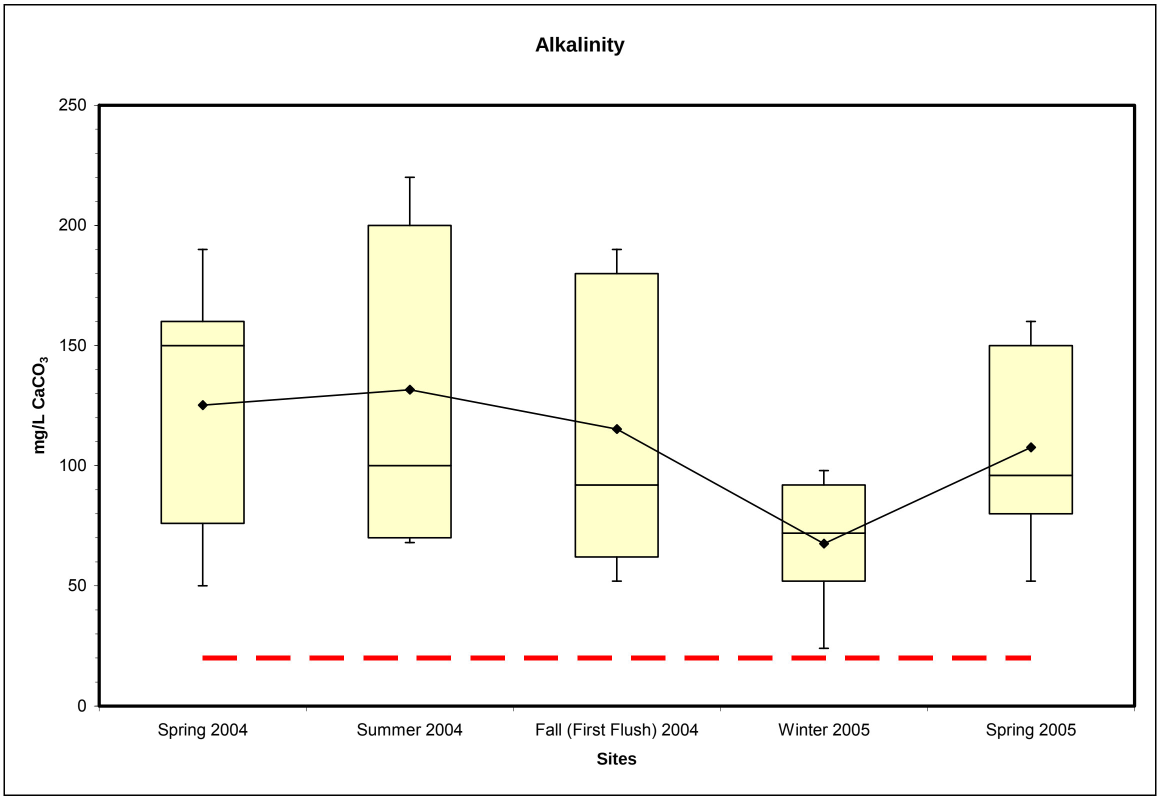
Table 3-9 Alkalinity Results

Alkalinity as $CaCO_3$	Units	K1	C1	PG1	PG3	PG5	Criteria[39]
Spring 2004	mg/L	76	160	190	150	50	>20
Summer 2004	mg/L	70	220	200	68	100	>20
Fall (First Flush) 2004	mg/L	52	190	180	62	92	>20
Winter 2005	mg/L	24	98	72	52	92	>20
Spring 2005	mg/L	52	96	160	150	80	>20

(a) Only bicarbonate was detected. Hydroxide and carbonate were at non detectable concentrations.

(b) Results reported are Bicarbonate as $CaCO_3$.

Figure 3-18 Alkalinity Temporal Analysis Graph



[39] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

Figure 3-19 Alkalinity Spatial Analysis Graph

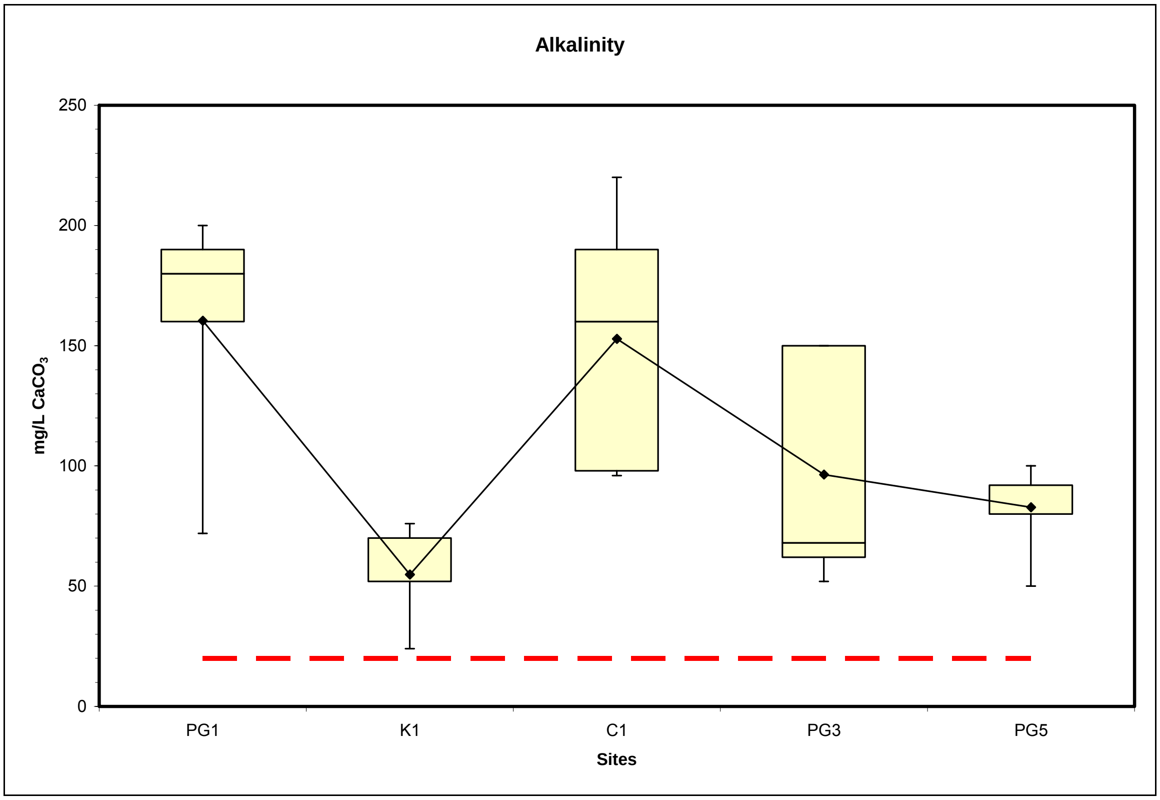


Table 3-10 Hardness Results

Hardness as $CaCO_3$	Units	K1	C1	PG1	PG3	PG5	Criteria
Spring 2004	mg/L	-	-	-	-	-	N/A
Summer 2004	mg/L	-	-	-	-	-	N/A
Fall (First Flush) 2004	mg/L	-	-	220	50	110	N/A
Winter 2005	mg/L	-	-	-	-	-	N/A
Spring 2005	mg/L	-	-	150	160	94	N/A

(a) A dash ("-") indicates no analysis was performed.

Figure 3-20 Hardness Spatial Analysis Graph

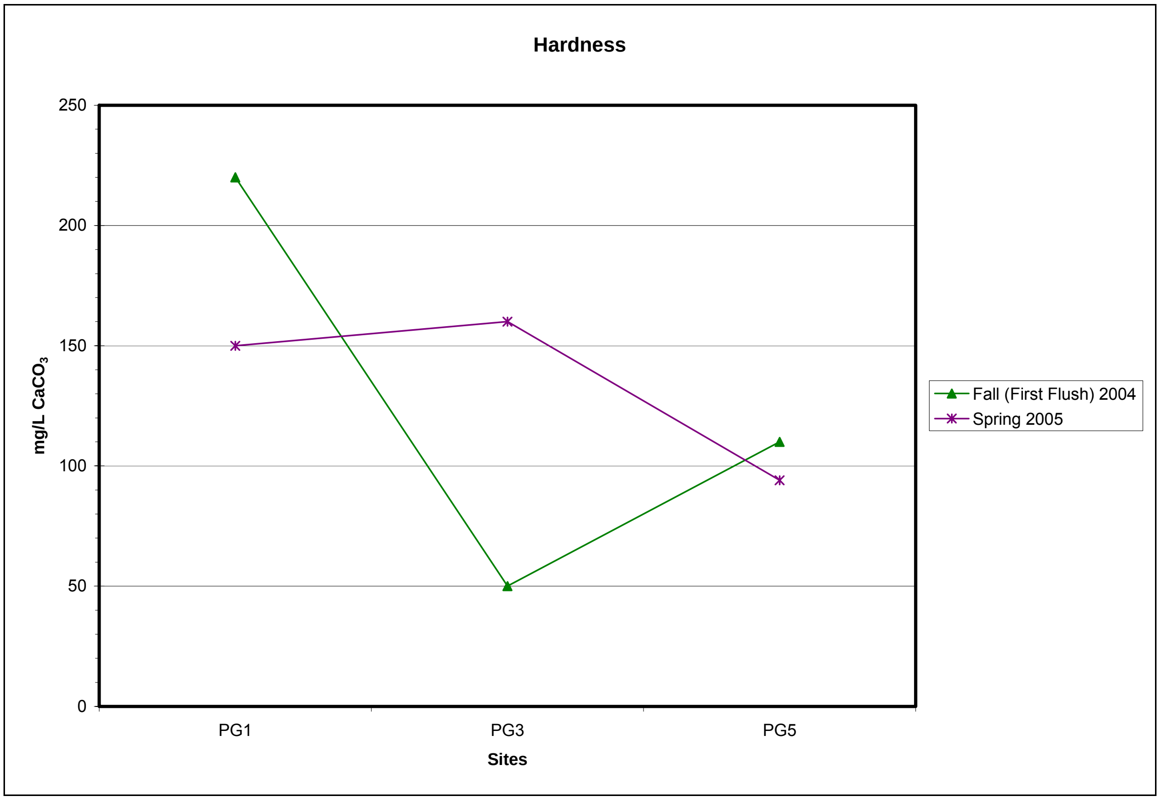


Table 3-11 Turbidity Results

Turbidity	Units	K1	C1	PG1	PG3	PG5	Criteria[40]
Spring 2004	NTU	6.3	450	2.3	8.2	44	Varies
Summer 2004	NTU	7.8	54	2.9	3	26	Varies
Fall (First Flush) 2004	NTU	55	9.2	22	7.3	12	Varies
Winter 2005	NTU	14	0.5	15	46	23	Varies
Spring 2005	NTU	8.9	29	2.8	5.5	13	Varies

[40] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-21 Turbidity Temporal Analysis Graph

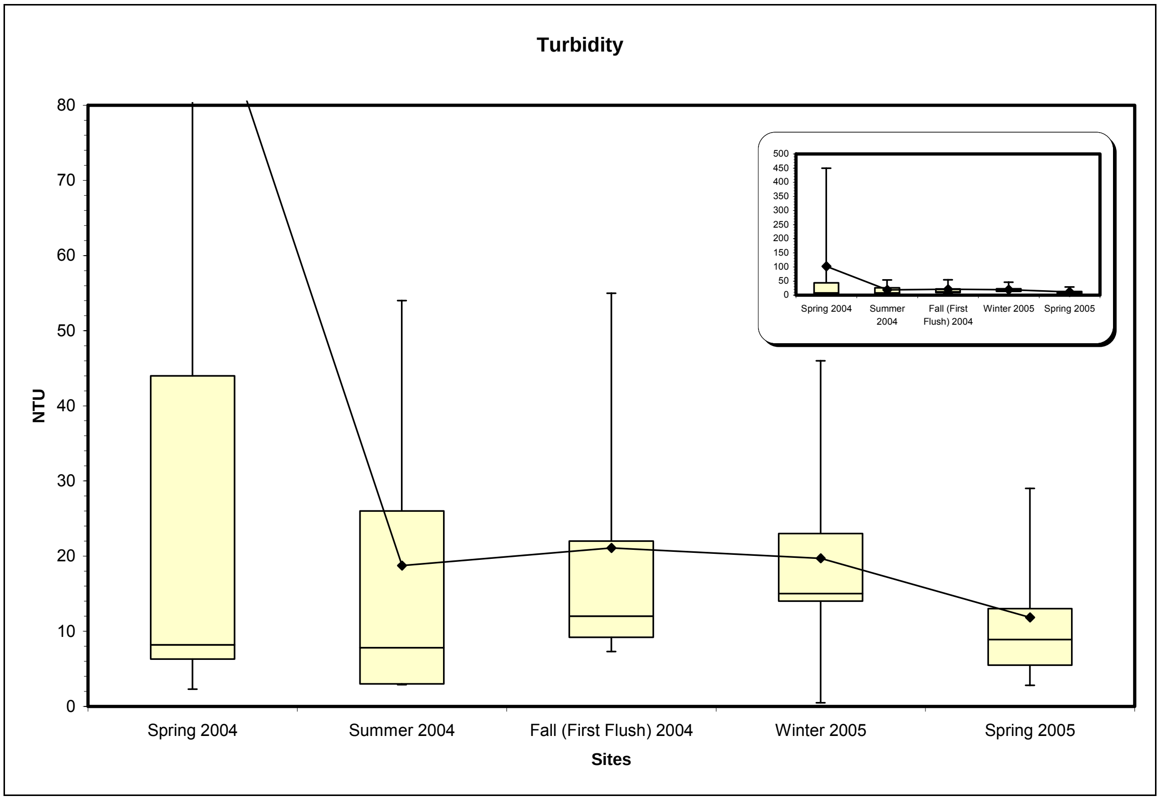


Figure 3-22 Turbidity Spatial Analysis Graph

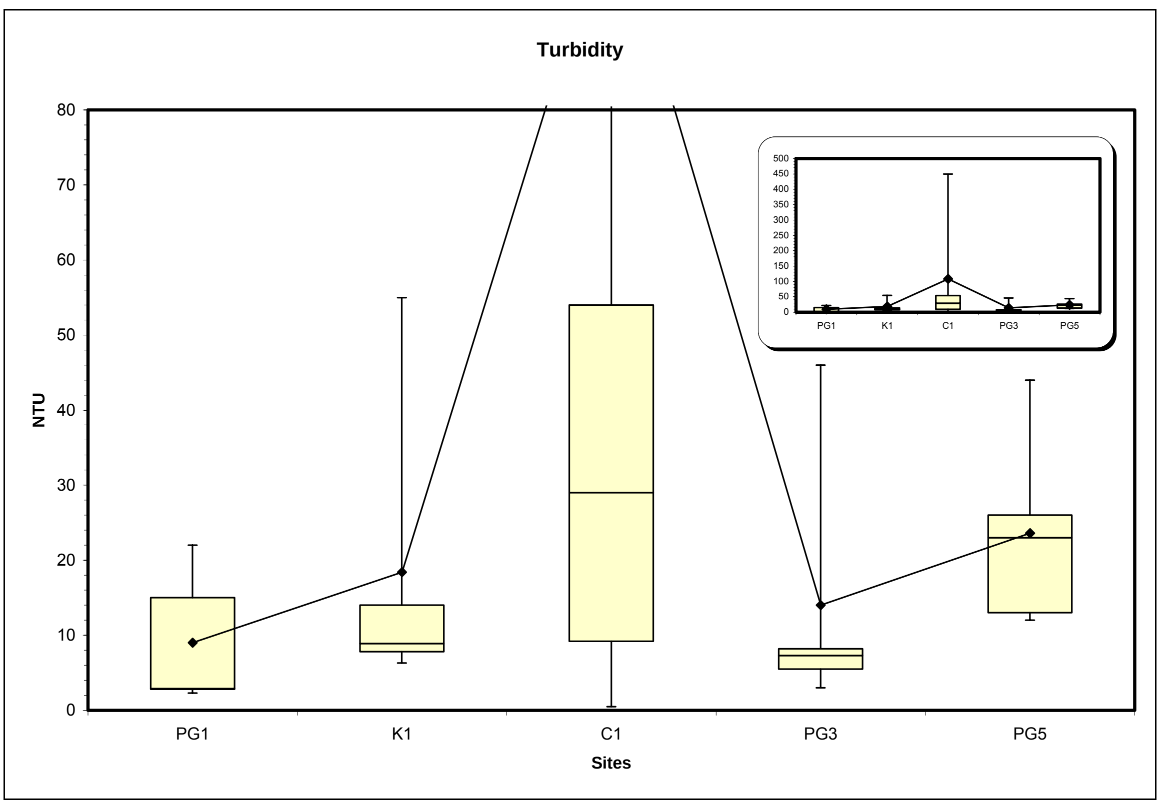
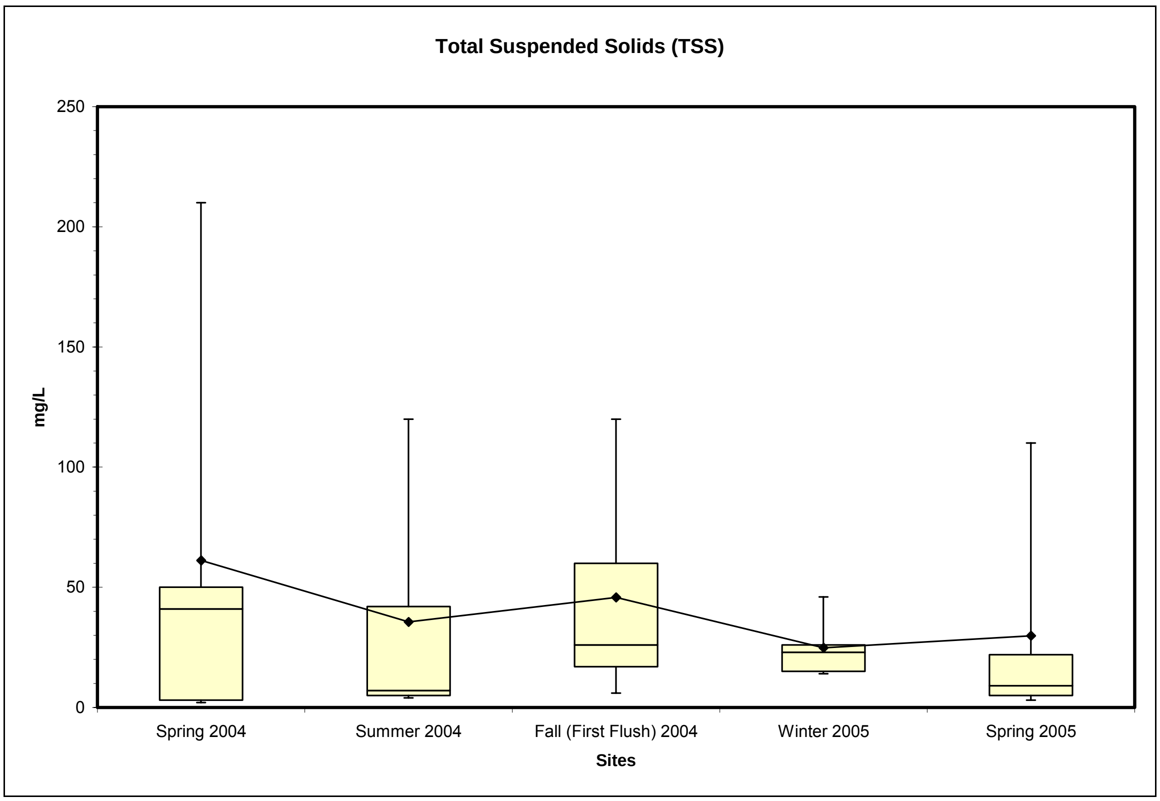


Table 3-12 Total Suspended Solids (TSS) Results

Total Suspended Solids	Units	K1	C1	PG1	PG3	PG5	Criteria[41]
Spring 2004	mg/L	2.0	210	3.0	50	41	Narrative
Summer 2004	mg/L	5.0	120	7.0	4.0	42	Narrative
Fall (First Flush) 2004	mg/L	120	26	60	17	6.0	Narrative
Winter 2005	mg/L	14	26	15	46	23	Narrative
Spring 2005	mg/L	22	110	3.0	5.0	9.0	Narrative

Figure 3-23 TSS Temporal Analysis Graph



[41] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-24 TSS Spatial Analysis Graph

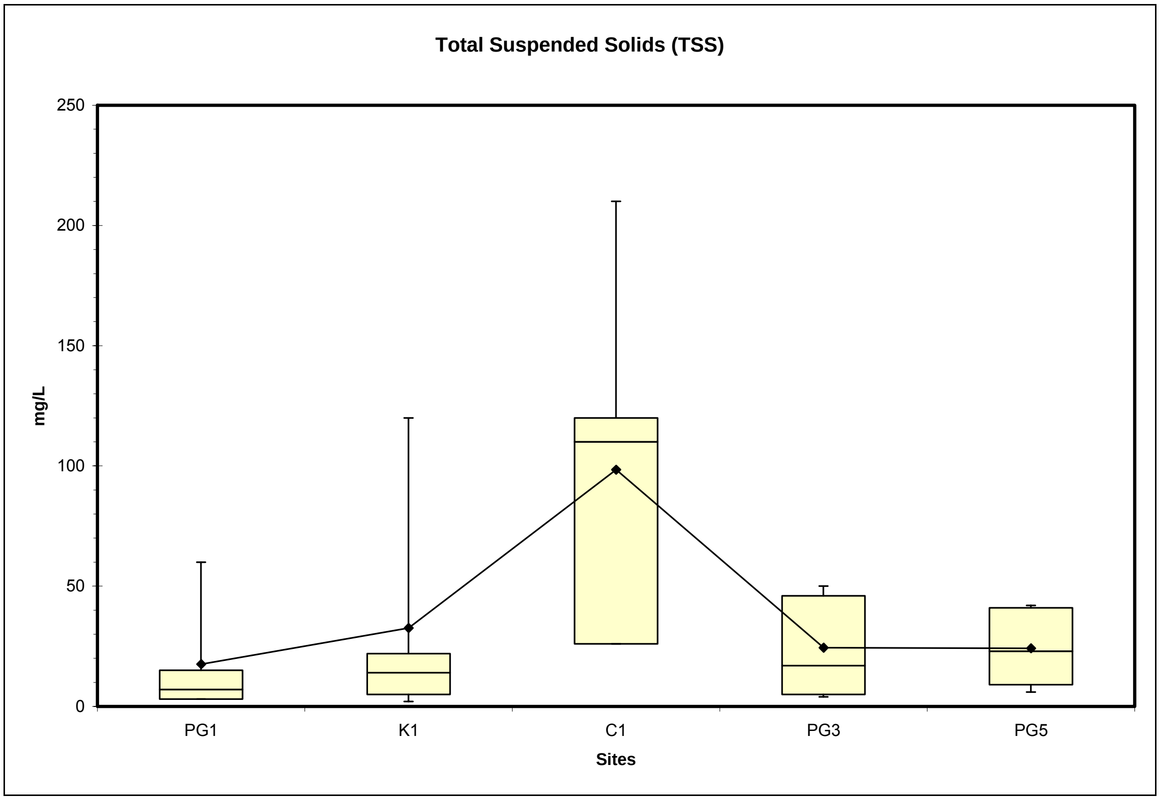


Table 3-13 Settleable Solids Results

Settleable Solids	Units	K1	C1	PG1	PG3	PG5	Criteria[42,43]
Spring 2004	ml/L	<0.10	<0.10	<0.10	<0.10	<0.10	Narrative
Summer 2004	ml/L	<0.10	<0.10	<0.10	<0.10	<0.10	Narrative
Fall (First Flush) 2004	ml/L	55	22	9.2	12	7.3	Narrative
Winter 2005	ml/L	<0.10	<0.10	<0.10	0.3	0.1	Narrative
Spring 2005	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	Narrative

[42] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

[43] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

Figure 3-25 Settleable Solids Spatial Analysis Graph

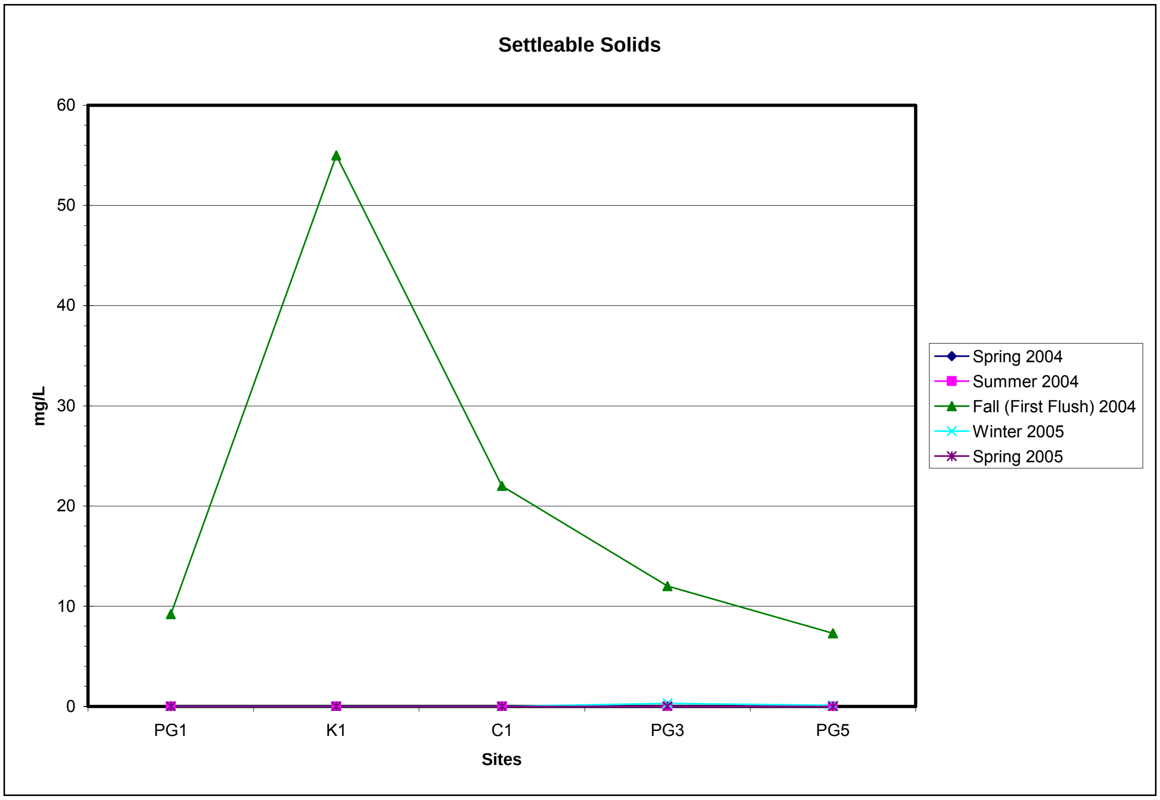


Table 3-14 Nitrate Results

Nitrate Nitrogen	Units	K1	C1	PG1	PG3	PG5	Criteria[44(a)]
Spring 2004	mg/L	<0.11	<0.11	<0.11	<0.11	<0.11	10
Summer 2004	mg/L	<0.11	<0.11	<0.11	<0.11	<0.11	10
Fall (First Flush) 2004	mg/L	0.29	<0.11	<0.11	<0.11	0.13	10
Winter 2005	mg/L	0.43	<0.11	0.40	0.33	2.00	10
Spring 2005	mg/L	<0.11	2.10	<0.11	<0.11	0.26	10

(a) The MCL for Nitrate + Nitrite (as nitrogen) is 10 mg/L[45]

[44] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.

[45] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.

Figure 3-26 Nitrate Temporal Analysis Graph

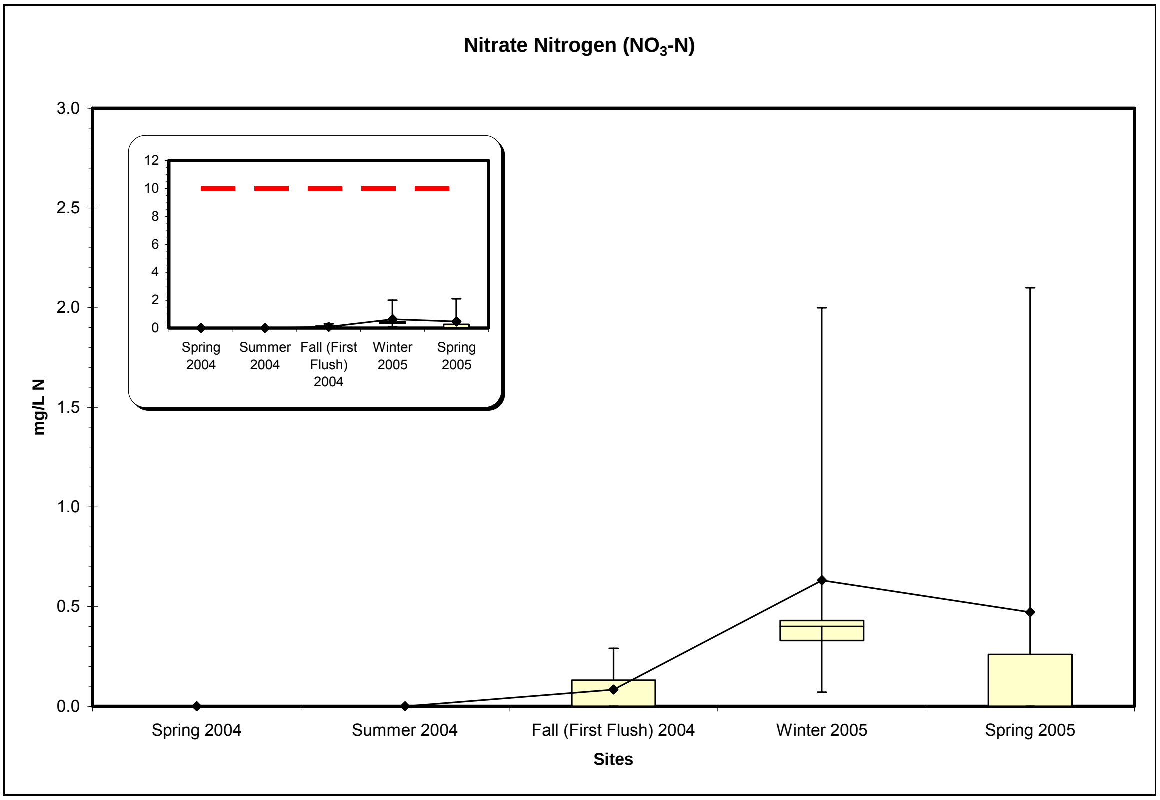


Figure 3-27 Nitrate Spatial Analysis Graph

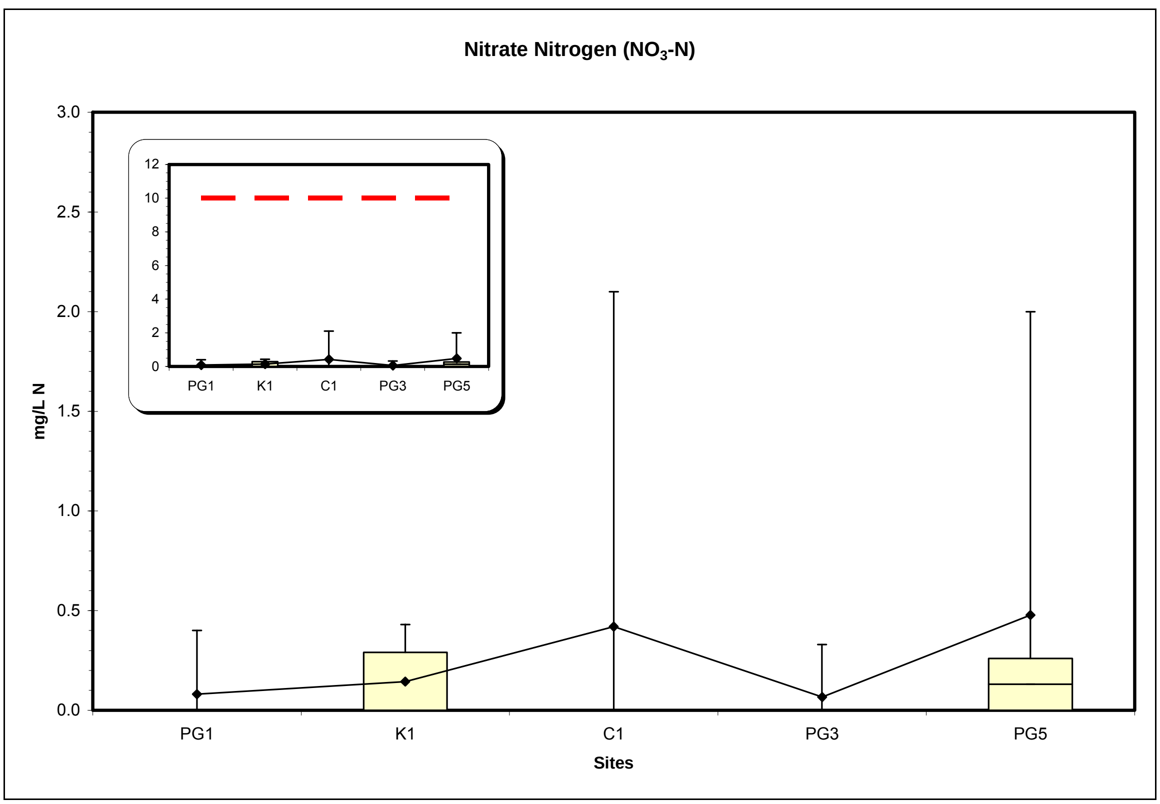
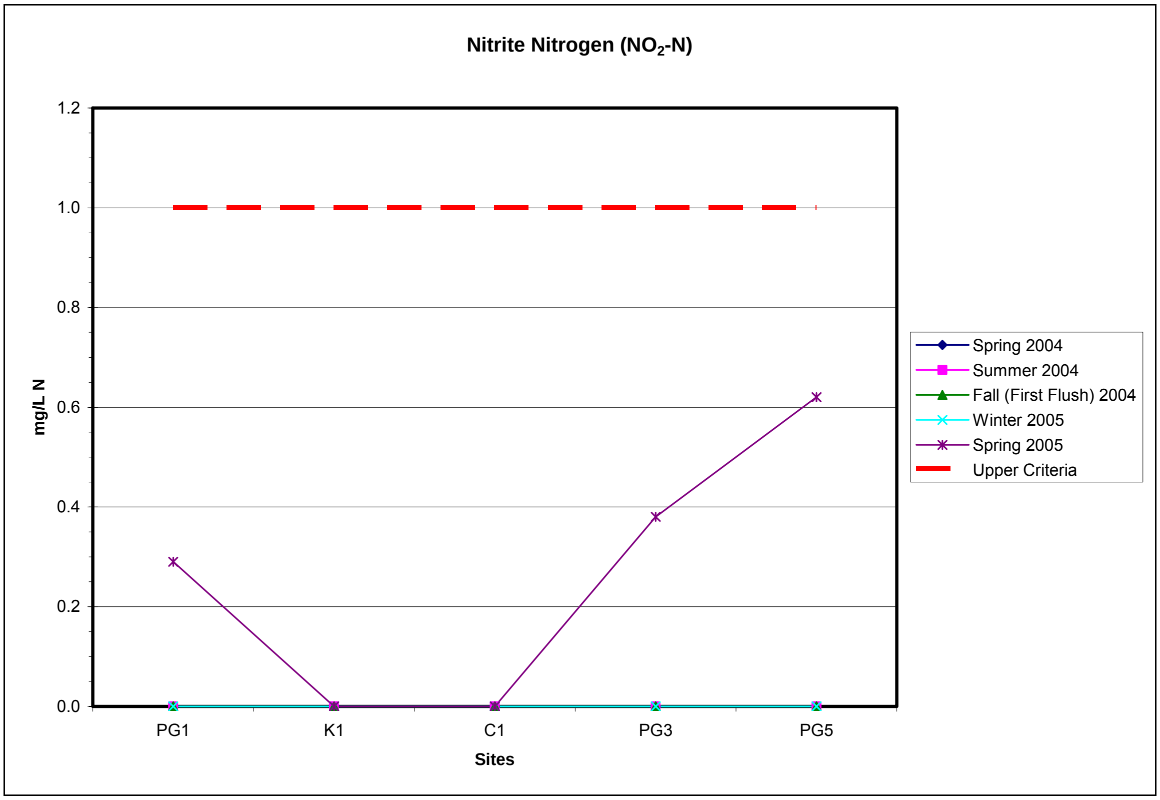


Table 3-15 Nitrite Results

Nitrite Nitrogen	Units	K1	C1	PG1	PG3	PG5	Criteria[46(a)]
Spring 2004	mg/L	<0.15	<0.15	<0.15	<0.15	<0.15	1
Summer 2004	mg/L	<0.15	<0.15	<0.15	<0.15	<0.15	1
Fall (First Flush) 2004	mg/L	<0.15	<0.15	<0.15	<0.15	<0.15	1
Winter 2005	mg/L	<0.15	<0.15	<0.15	<0.15	<0.15	1
Spring 2005	mg/L	<0.15	<0.15	0.29	0.38	0.62	1

(a) The MCL for Nitrate + Nitrite (as nitrogen) is 10 mg/L[47]

Figure 3-28 Nitrite Spatial Analysis Graph

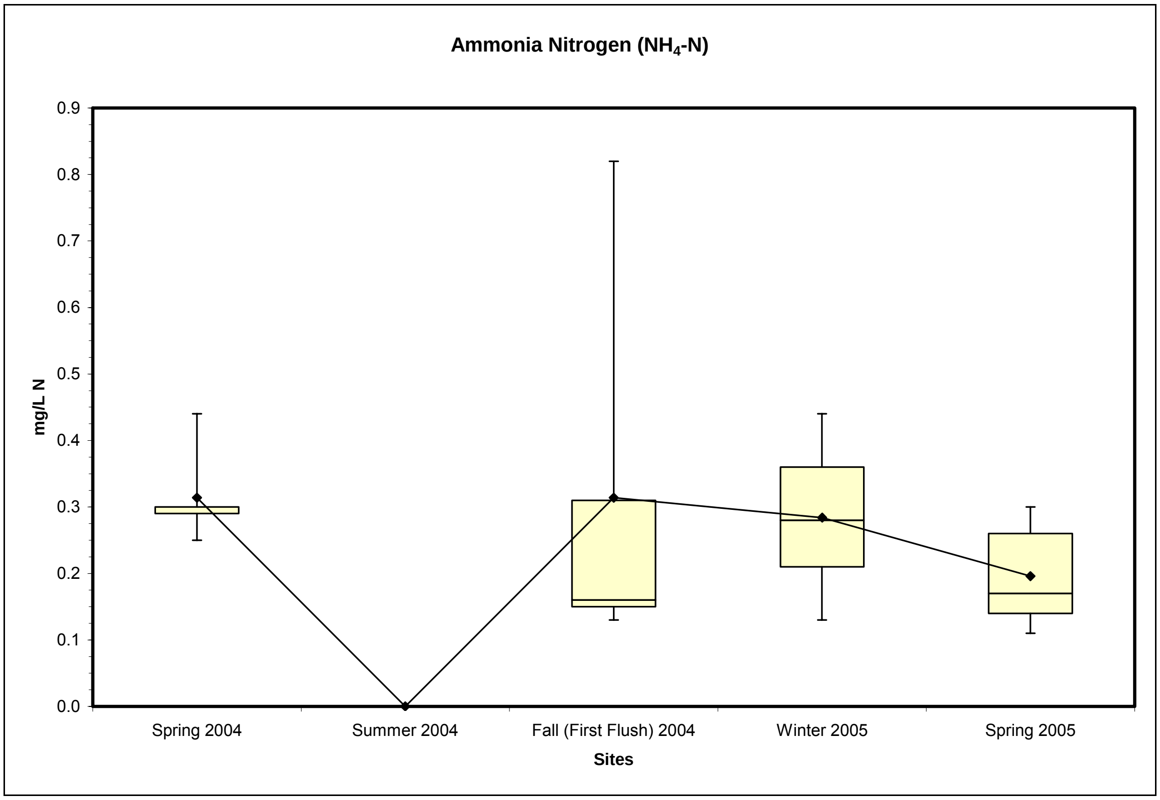


[46] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.
[47] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.

Table 3-16 Ammonia Results

Ammonia Nitrogen	Units	K1	C1	PG1	PG3	PG5	Criteria[48]
Spring 2004	mg/L	0.29	0.44	0.30	0.29	0.25	Narrative
Summer 2004	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	Narrative
Fall (First Flush) 2004	mg/L	0.31	0.82	0.13	0.15	0.16	Narrative
Winter 2005	mg/L	0.28	0.44	0.21	0.13	0.36	Narrative
Spring 2005	mg/L	0.17	0.30	0.14	0.11	0.26	Narrative

Figure 3-29 Ammonia Temporal Analysis Graph



[48] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-30 Ammonia Spatial Analysis Graph

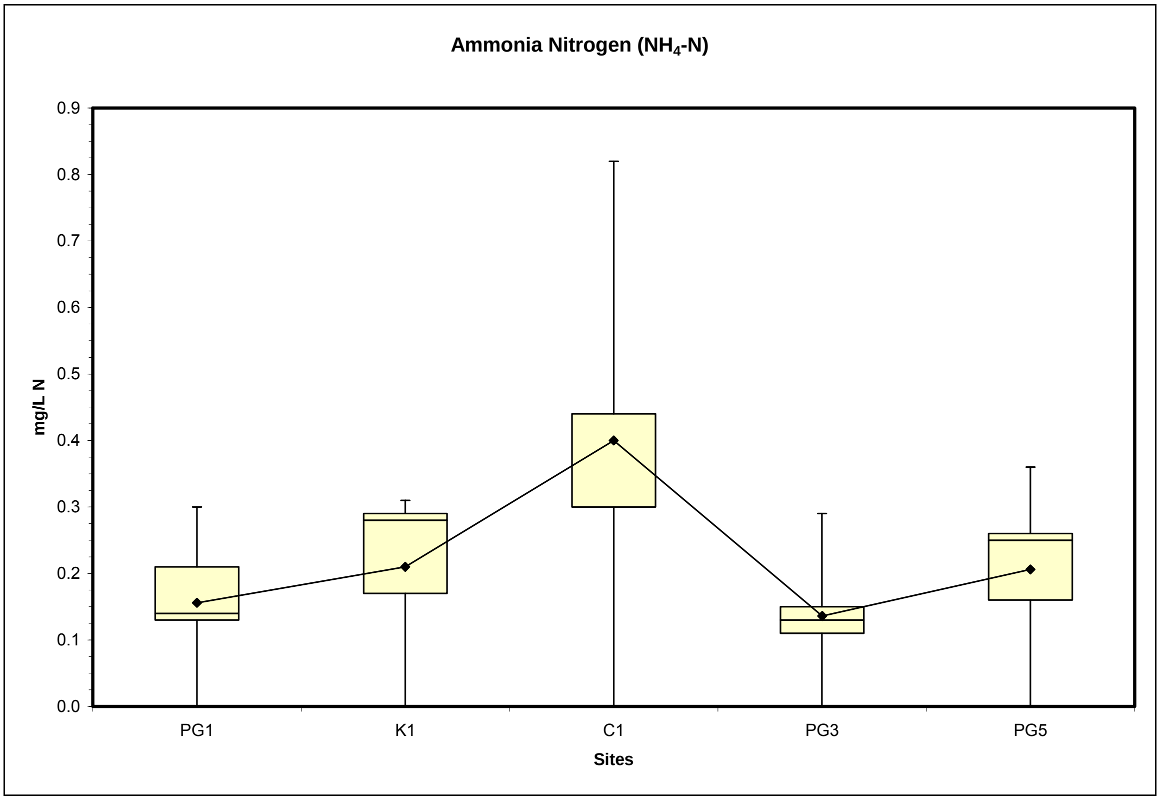


Table 3-17 Phosphate Results

Phosphate Phosphorus	Units	K1	C1	PG1	PG3	PG5	Criteria[49]
Spring 2004	mg/L	<0.33	<0.33	<0.33	<0.33	<0.33	Narrative
Summer 2004	mg/L	<0.33	<0.33	<0.33	<0.33	<0.33	Narrative
Fall (First Flush) 2004	mg/L	<0.33	<0.33	<0.33	<0.33	<0.33	Narrative
Winter 2005	mg/L	<0.33	<0.33	<0.33	<0.33	<0.33	Narrative
Spring 2005	mg/L	<0.33	<0.33	<0.33	<0.33	<0.33	Narrative

Table 3-18 Biological Oxygen Demand (BOD) Results

Biochemical Oxygen Demand	Units	K1	C1	PG1	PG3	PG5	Criteria
Spring 2004	mg/L	<5.0	5.5	<5.0	<5.0	<5.0	N/A
Summer 2004	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	N/A
Fall (First Flush) 2004	mg/L	5.5	<5.0	<5.0	<5.0	<5.0	N/A
Winter 2005	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	N/A
Spring 2005	mg/L	13.0	18.0	5.3	<5.0	<5.0	N/A

[49] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-31 BOD Temporal Analysis Graph

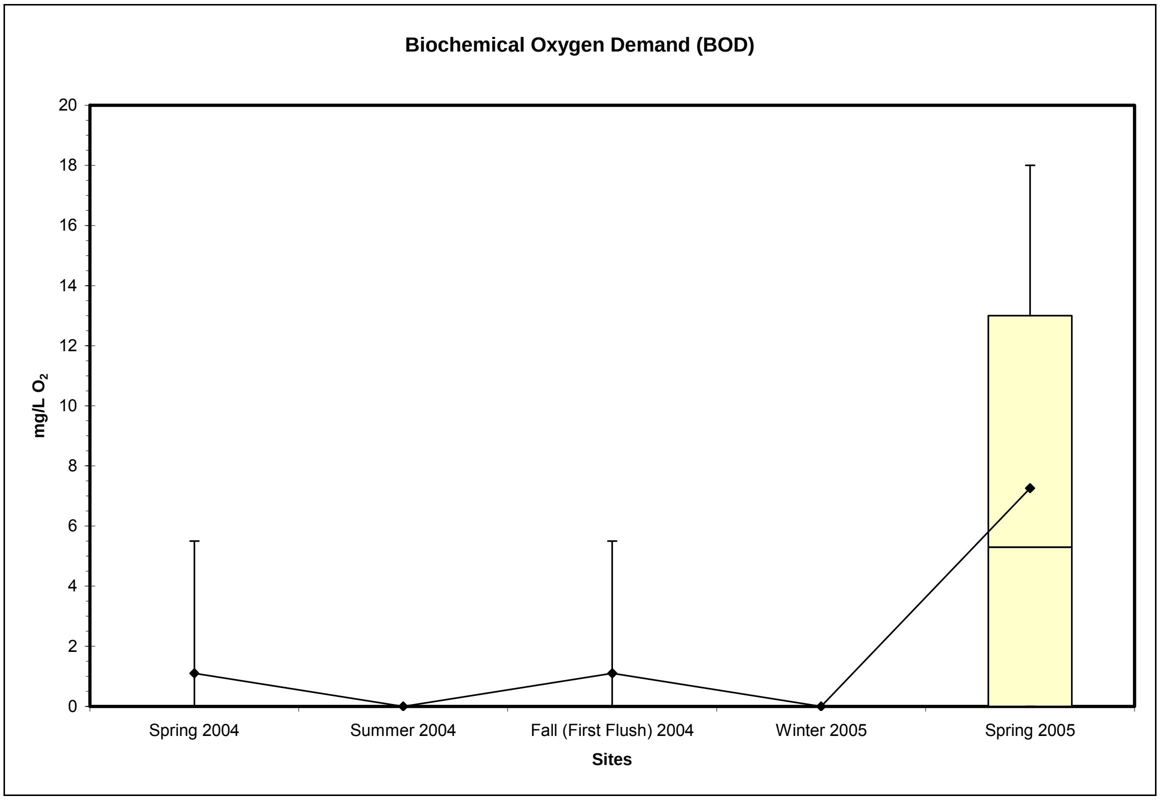


Figure 3-32 BOD Spatial Analysis Graph

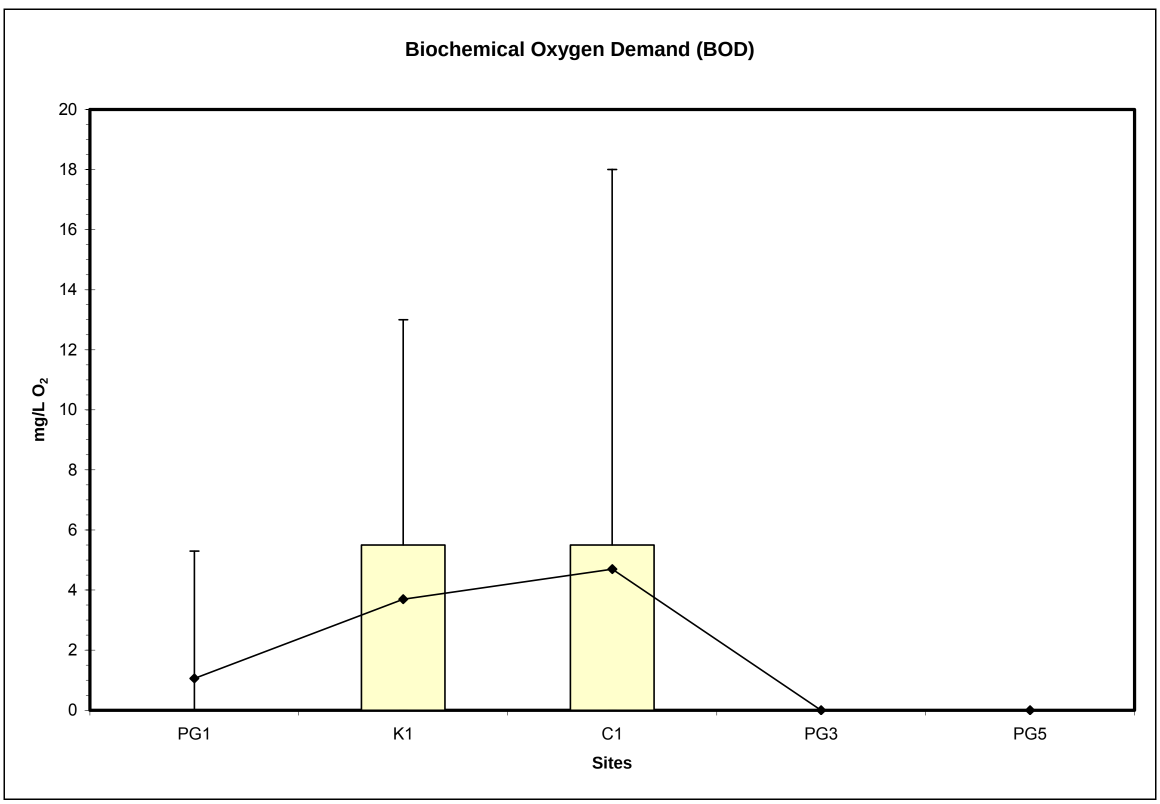
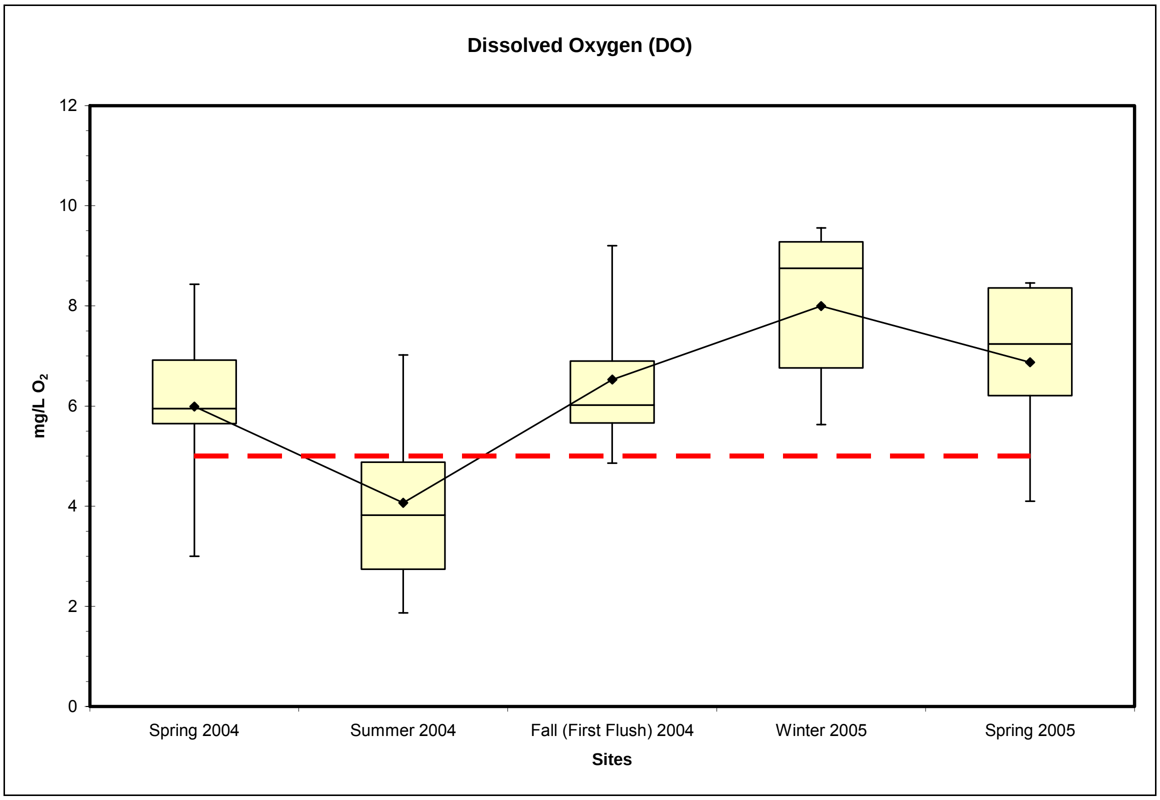


Table 3-19 Dissolved Oxygen (DO) Results

Dissolved Oxygen	Units	K1	C1	PG1	PG3	PG5	Criteria[50]
Spring 2004	mg/L	5.7	3.0	8.4	6.9	6.0	5.0
Summer 2004	mg/L	1.9	2.7	4.9	7.0	3.8	5.0
Fall (First Flush) 2004	mg/L	5.7	6.0	6.9	4.9	9.2	5.0
Winter 2005	mg/L	6.8	5.6	8.8	9.6	9.3	5.0
Spring 2005	mg/L	7.2	8.5	6.2	8.4	4.1	5.0

Figure 3-33 DO Temporal Analysis Graph



[50] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-34 DO Spatial Analysis Graph

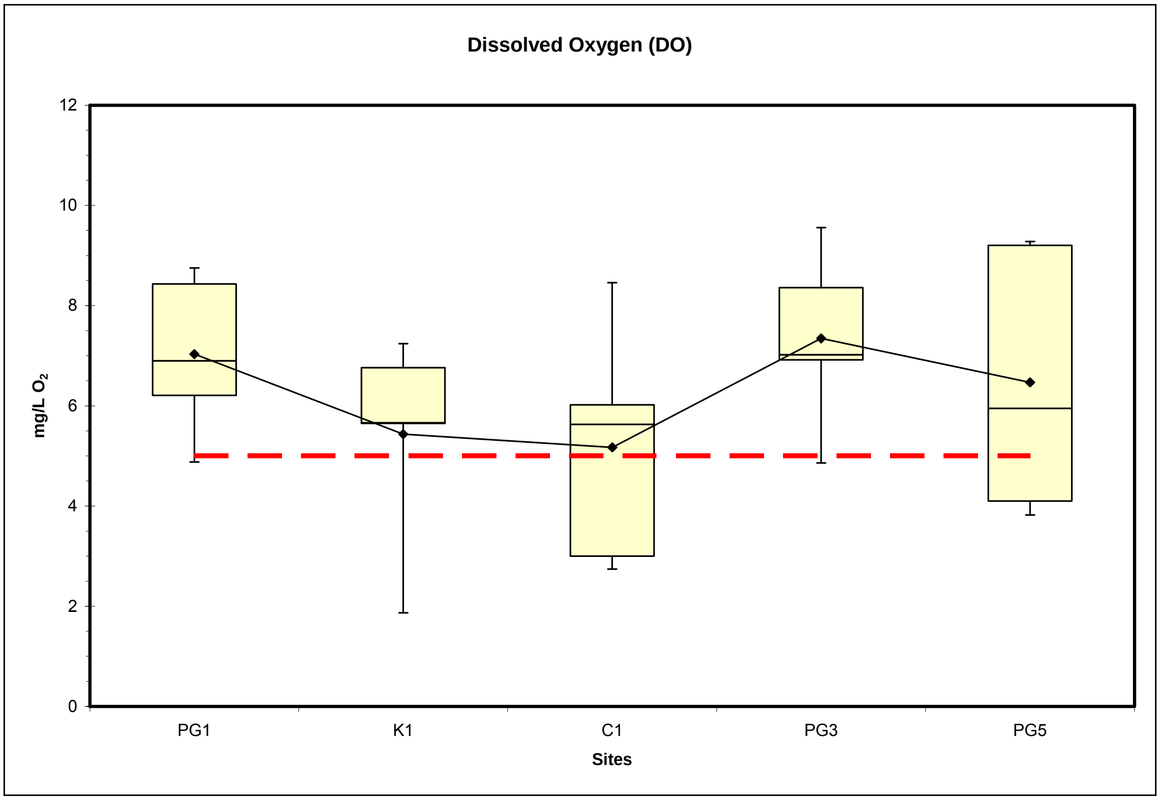


Table 3-20 Oil and Grease Results

Oil and Grease	Units	K1	C1	PG1	PG3	PG5	Criteria[51]
Spring 2004	mg/L	<10	<10	<10	<10	<10	Narrative
Summer 2004	mg/L	<10	<10	<10	<10	<10	Narrative
Fall (First Flush) 2004	mg/L	<10	<10	<10	<10	<10	Narrative
Winter 2005	mg/L	<10	<10	<10	<10	<10	Narrative
Spring 2005	mg/L	790	<10	<10	55	<10	Narrative

[51] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-35 Oil and Grease Spatial Analysis Graph

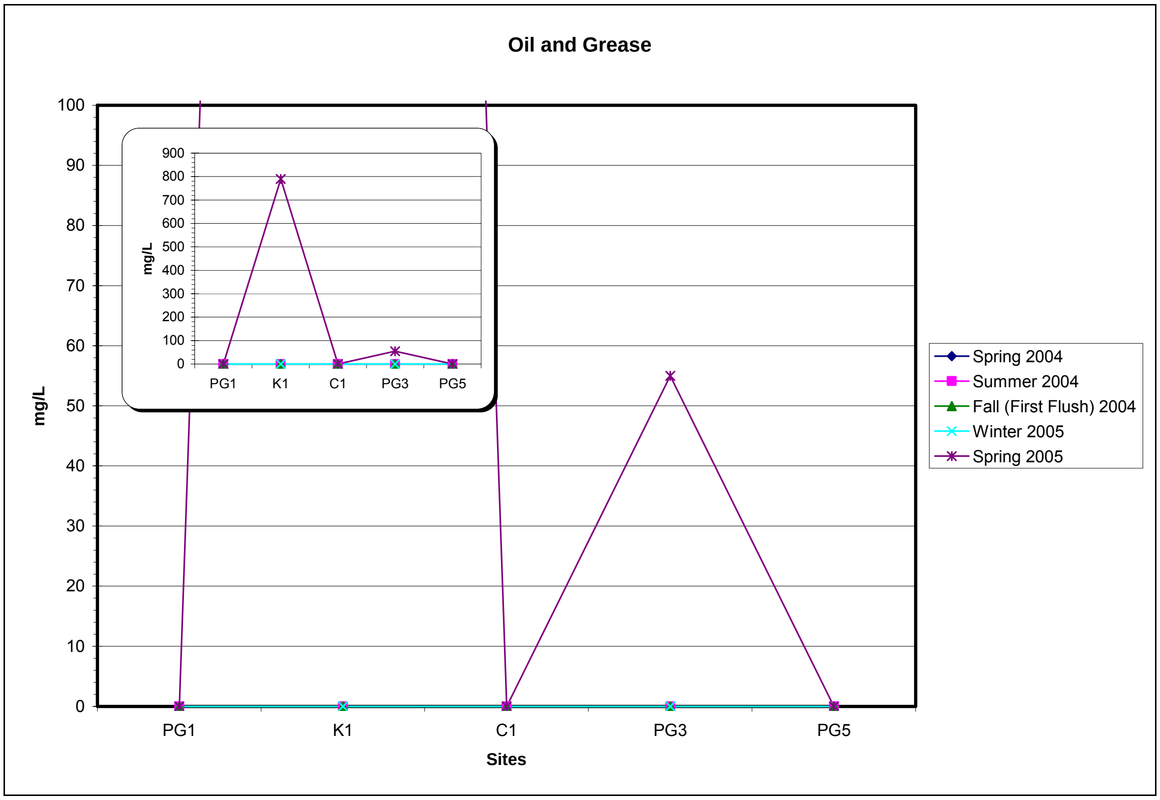


Table 3-21 Total Coliform Results

Total Coliform	Units	K1	C1	PG1	PG3	PG5	Criteria
Spring 2004 (a)	MPN/100mL	3,500	78	490	230	790	N/A
Summer 2004 (d)	MPN/100mL	-	-	-	-	-	N/A
Fall (First Flush) 2004 (a)(b)	MPN/100mL	>1,600	>1,600	>1,600	>1,600	>1,600	N/A
Winter 2005 (c)	MPN/100mL	50,000	8,000	90,000	800	840	N/A
Spring 2005 (c)	MPN/100mL	1,700	30,000	80	(e)	130	N/A

(a) Standard method 9221 3x5 tube with 10:1 dilution.

(b) Exceeds upper reporting limit.

(c) Standard method 9221 5x5 tube.

(d) No analysis was performed.

(e) Sample bottle broke during transport. No analysis was performed.

Figure 3-36 Total Coliform Temporal Analysis Graph

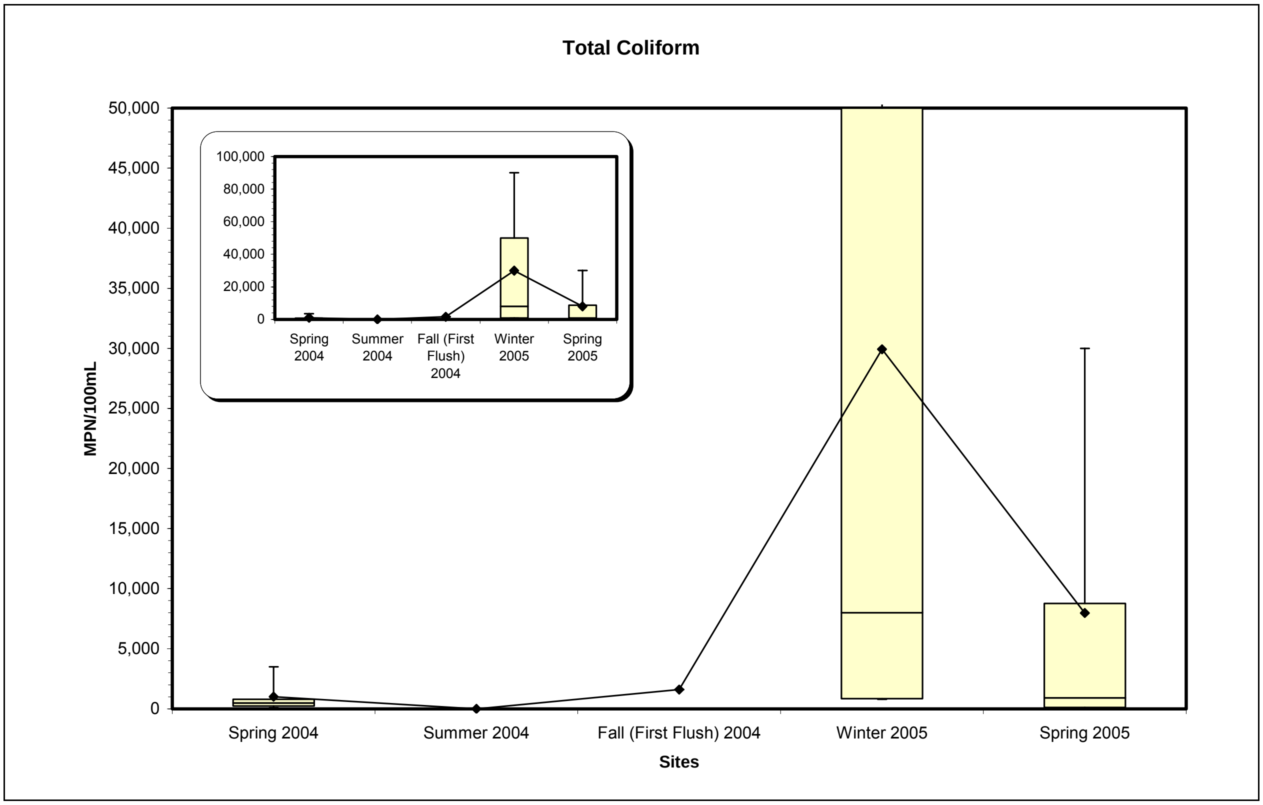


Figure 3-37 Total Coliform Spatial Analysis Graph

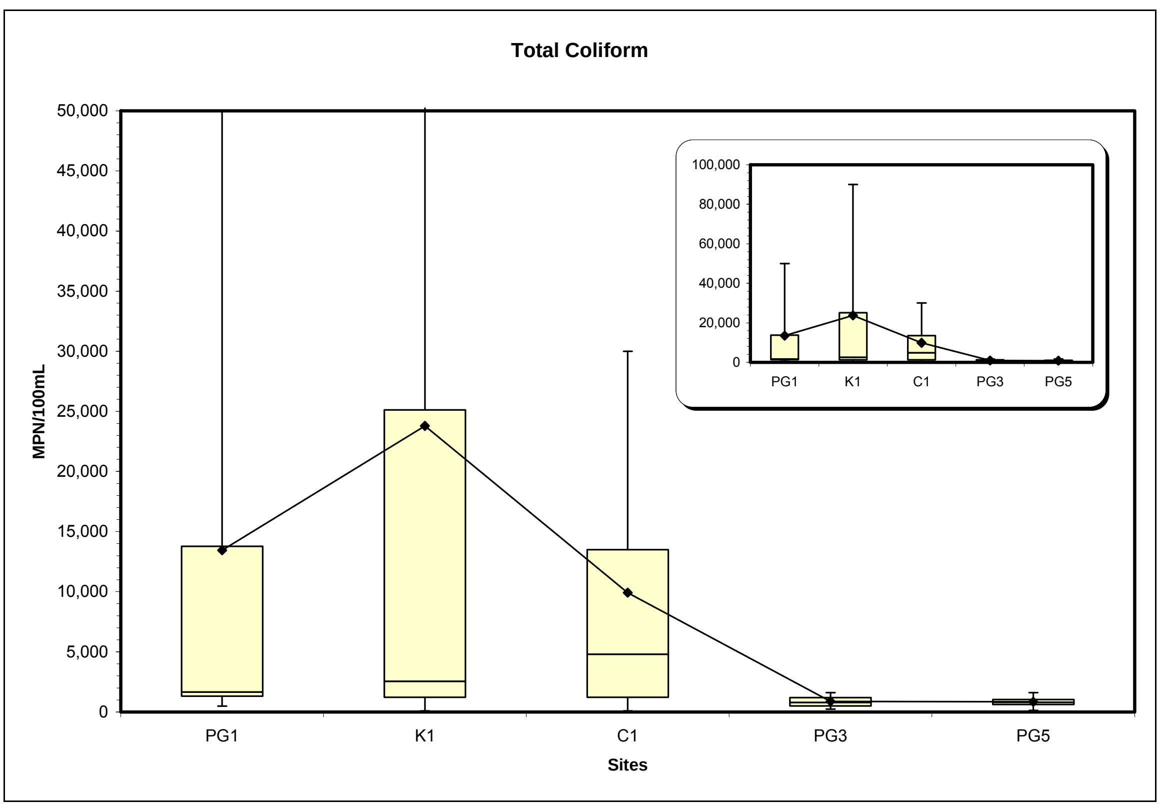


Table 3-22 *E. coli* Results

E. coli	**Units**	**K1**	**C1**	**PG1**	**PG3**	**PG5**	**Criteria(e)**
Spring 2004 (a)	MPN/100mL	ND	ND	ND	ND	ND	N/A
Summer 2004 (d)	MPN/100mL	-	-	-	-	-	N/A
Fall (First Flush) 2004 (a)	MPN/100mL	>1,600 (b)	1,600	1,600	500	900	N/A
Winter 2005 (c)	MPN/100mL	13,000	170	50,000	230	500	N/A
Spring 2005 (c)	MPN/100mL	1,300	30,000	80	30	30	N/A

(a) Standard method 9221 3x5 tube with 10:1 dilution.

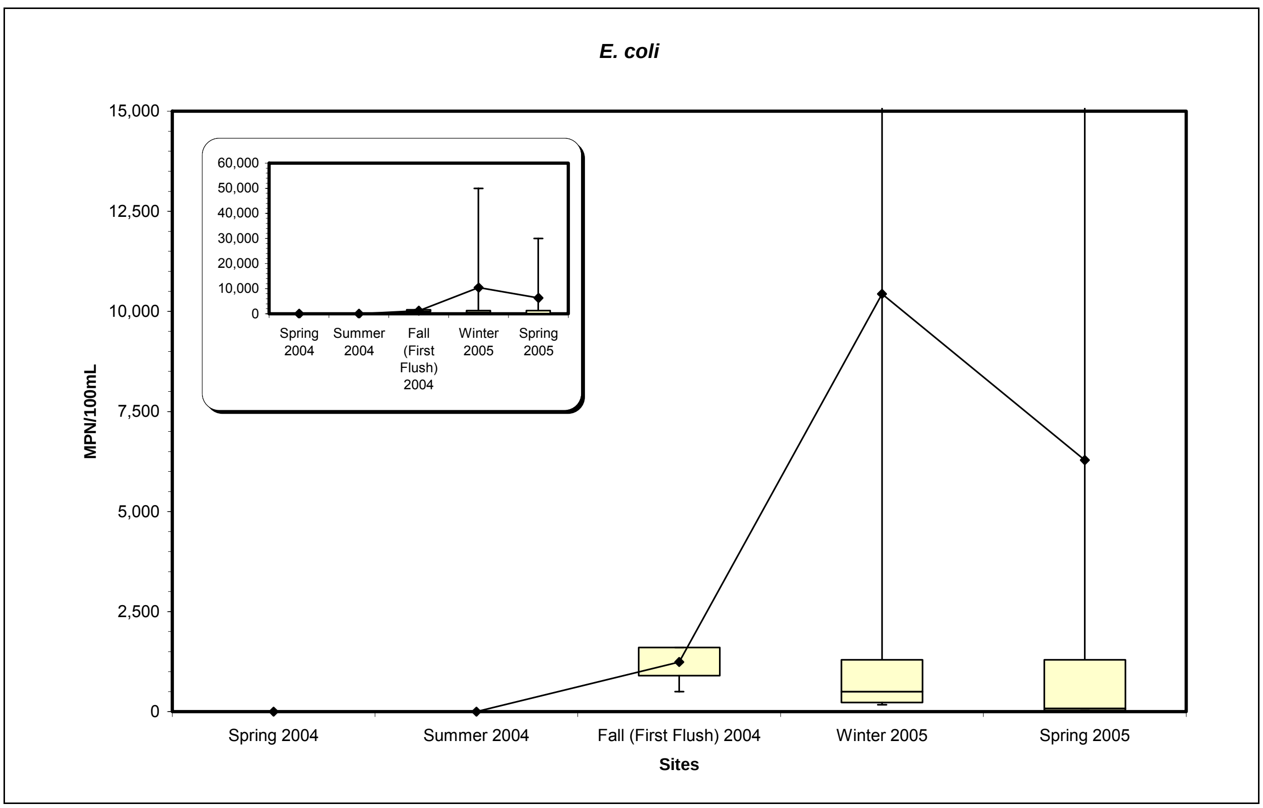
(b) Exceeds upper reporting limit.

(c) Standard method 9221 5x5 tube.

(d) No analysis was performed.

(e) Fecal coliform water quality objective is 10 percent of total number of samples taken during any 30-day period shall not exceed 400/100ml.[52]

Figure 3-38 *E. coli* Temporal Analysis Graph



[52] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

Figure 3-39 *E. coli* Spatial Analysis Graph

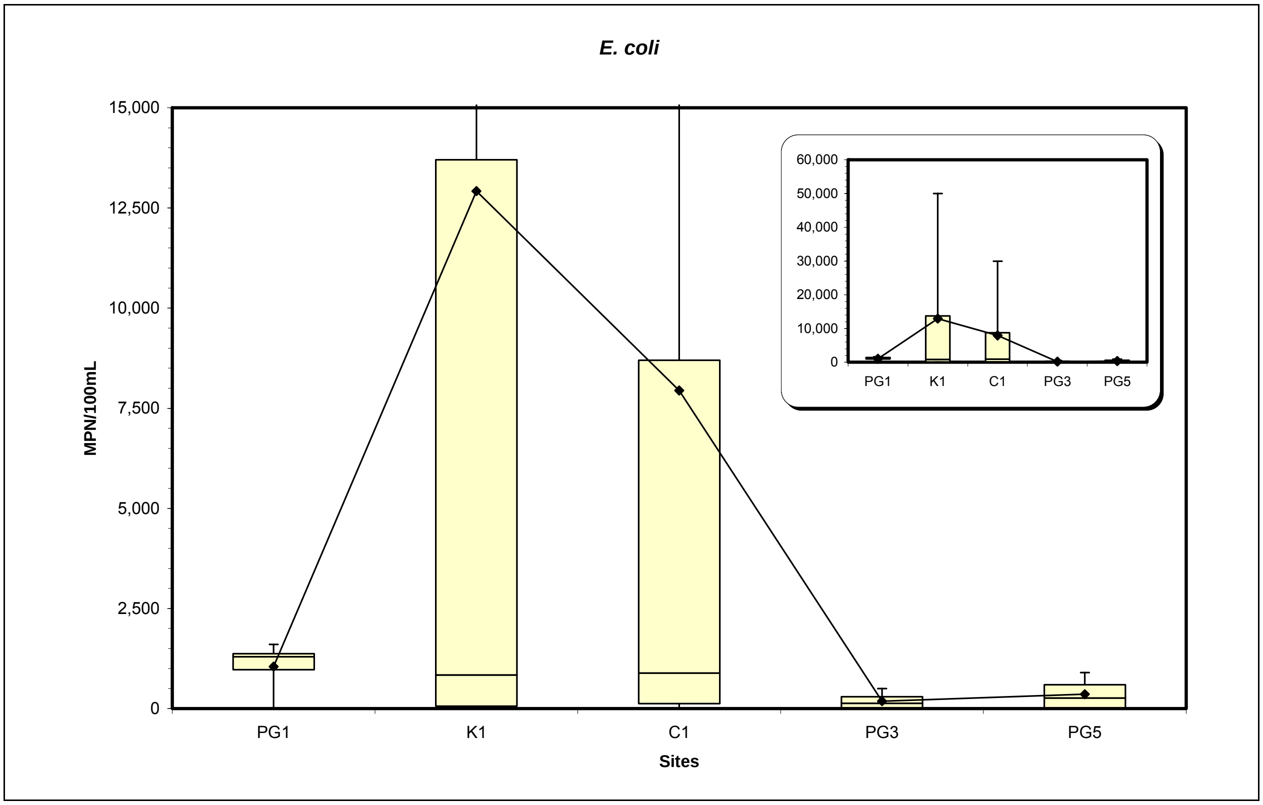


Table 3-23 Organochlorine Herbicides Results

Organochlorine Herbicides	Units	Spring 2004 PG1	Spring 2004 PG3	Spring 2004 PG5	Fall (First Flush) 2004 PG1	Fall (First Flush) 2004 PG3	Fall (First Flush) 2004 PG5	Spring 2005 PG1	Spring 2005 PG3	Spring 2005 PG5	Criteria [53,54]
2,4,5-T	µg/L	<0.8	<0.8	<0.8	(a)	(a)	(a)	(a)	(a)	(a)	70
2,4,5-TP (Silvex)	µg/L	<0.4	<0.4	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	50
2,4-T	µg/L	(a)	(a)	(a)	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	N/A
2,4-DB	µg/L	<4.0	<4.0	<4.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	56
2,4-D	µg/L	<1.6	<1.6	<1.6	<0.04	<0.04	<0.04	0.68	0.58	0.07	70
Dalapon	µg/L	(a)	(a)	(a)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	200
Dicamba	µg/L	(a)	(a)	(a)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	200
Dichloroprop	µg/L	<4.0	<4.0	<4.0	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	N/A
Dinoseb	µg/L	<0.4	<0.4	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	7
MCPA	µg/L	(a)	(a)	(a)	<10	<10	<10	<10	<10	<10	11
MCPP	µg/L	(a)	(a)	(a)	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	7
4,Nitrophenol	µg/L	(a)	(a)	(a)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Pentachlorophenol	µg/L	(a)	(a)	(a)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1

(a) No analysis was performed.

[53] California Regional Water Quality Control Board, Central Valley Region. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basins and The San Joaquin River Basin, Fourth Edition 1998.

[54] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 5.5 Section 64444.

Table 3-24 Organophosphate Pesticide Results

Organophosphate Pesticides	Units	Spring 2004 PG1	Spring 2004 PG3	Spring 2004 PG5	Fall (First Flush) 2004 PG1	Fall (First Flush) 2004 PG3	Fall (First Flush) 2004 PG5	Spring 2005 PG1	Spring 2005 PG3	Spring 2005 PG5	Criteria [55]
Azinophos Methyl	µg/L	<0.5	<0.5	<0.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	N/A
Bolstar	µg/L	<0.2	<0.2	<0.2	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	N/A
Coumaphos	µg/L	<0.5	<0.5	<0.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	N/A
Demeton	µg/L	<0.2	<0.2	<0.2	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.3
Diazinon	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	6
Dichlorvos	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3.5
Disulfoton	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3
Dursban	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.1
Ethoprop	µg/L	<0.2	<0.2	<0.2	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	N/A
Fensulfothion	µg/L	<0.2	<0.2	<0.2	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	N/A
Fenthion	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	N/A
Gardona (Stirophos)	µg/L	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	N/A
Malation	µg/L	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	N/A
Merphos	µg/L	<0.2	<0.2	<0.2	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.2
Methyl Parathion	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2
Mevinphos	µg/L	<0.2	<0.2	<0.2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	N/A
Naled	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	14
Phorate	µg/L	<0.2	<0.2	<0.2	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.7
Ronnel	µg/L	<0.2	<0.2	<0.2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	N/A
Tokuthion	µg/L	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	N/A
Trichloronate	µg/L	<0.2	<0.2	<0.2	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	N/A

Note: dash ("-") indicates no analysis was performed.

Table 3-25 Pesticide Results

Pesticides	Units	Spring 2004 PG1	Spring 2004 PG3	Spring 2004 PG5	Fall (First Flush) 2004 PG1	Fall (First Flush) 2004 PG3	Fall (First Flush) 2004 PG5	Spring 2005 PG1	Spring 2005 PG3	Spring 2005 PG5	Criteria [56,57]
Alpha-BHC	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A
Beta-BHC	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A
Gamma-BHC	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2
Delta-BHC	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A
Heptachlor	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.01
Aldrin	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.21
Heptachlor epoxide	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.01
Gamma-Chlordane	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A
Endosulfan-I	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	42
Alpha-Chlordane	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A

[55] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

[56] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

[57] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 5.5 Section 64444.

Pesticides	Units	Spring 2004 PG1	Spring 2004 PG3	Spring 2004 PG5	Fall (First Flush) 2004 PG1	Fall (First Flush) 2004 PG3	Fall (First Flush) 2004 PG5	Spring 2005 PG1	Spring 2005 PG3	Spring 2005 PG5	Criteria [56,57]
4,4'-DDE	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.1
Dieldrin	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35
Endrin	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	2
Endosulfan II	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.22
4,4'-DDD	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.15
Endrin Aldehyde	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.76
Endosulfan sulfate	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	110
4,4'-DDT	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.1
Endrine ketone	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A
Methoxychlor	µg/L	<0.20	<0.20	<0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	30
Glyphosate	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	700

Table 3-26 CAM 17 Metals Results

Metals (CAM 17)	Units	Spring 2004			Fall (First Flush) 2004			Spring 2005			Criteria[58,59,60]
		PG1	PG3	PG5	PG1	PG3	PG5	PG1	PG3	PG5	
Antimony	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	6
Arsenic	µg/L	<1.0	<1.0	<1.0	1.6	1.2	1.6	1.6	1.7	1.7	50
Barium	µg/L	140	71	110	21	11	56	140	100	72	1,000
Beryllium	µg/L	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4
Cadmium (a)	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	5
Chromium	µg/L	8	8	8	1.6	1.2	2.2	<0.50	8.7	2.3	50
Cobalt	µg/L	<0.50	0.86	0.5	1.2	<0.59	0.86	0.5	0.5	1.6	50
Copper	µg/L	3.1	4.2	2.4	2.4	4.6	2.8	1.8	2.7	3	1,000
Lead	µg/L	<1.0	1.5	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	1.3	15
Mercury	µg/L	0.25	0.25	0.25	<0.20	<0.20	<0.20	0.25	<0.20	<0.20	2
Molybdenum	µg/L	0.98	0.7	1	1.2	1.2	0.66	0.91	0.84	5.1	35
Nickel	µg/L	8	8	8	2.5	1.7	1.7	2.8	5.9	4.5	100
Selenium	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	50
Silver	µg/L	8	8	8	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	100
Thallium (b)	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	2
Vanadium	µg/L	1.9	3.7	3.2	6.2	4.3	5.2	5.9	6	8.5	50
Zinc	µg/L	<1.0	<1.0	<1.0	<10	<10	<10	<10	<10	20	5,000

(a) The Cadmium results show that the California Toxics Rule Criteria are met, but the USEPA National Recommended Water Quality Criteria to Protect Freshwater Aquatic Life is lower than the reporting limit of 0.5 µg/L. This means that there is a possibility the USEPA criteria may have been exceeded[61].

(b) The Thallium results show the California Public Health Goal Criteria is lower than the reporting limit of 0.1 µg/L. This means that the criteria may have been exceeded[62].

Summary

For a historically intermittent, warm water fishery system, the creek water is of generally good quality. Table 3-27 summarizes the level of concern that the results and analysis from this study suggest for each of the parameters analyzed. A step-wise numeric scale with 1 representing little or no concern and 5 representing a high level of concern that the parameter is adversely affecting water quality is used.

The only parameters that consistently exceeded the relevant water quality criteria and raise obvious concerns for the entire watershed are total coliform

[58] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

[59] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 4, Section 64431.

[60] California Code of Regulations (CCR). Title 22, Division 4, Chapter 15, Article 16, Section 64449.

[61] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

[62] California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. A Compilation of Water Quality Goals, August 2003.

and *E. coli*. Exact sources for the high bacteria counts are unknown at this time, but wildlife is the logical source. A secondary concern would be identifying sources of sediment in the Curry Creek system and determine if there are reasonable ways to reduce sediment impacts to the creek.

The Curry Creek site (C1) was selected to represent a non-developed agricultural drainage area, and as such stood out in a number of the analysis. The creek's temperature, nitrite, and DO were all lower than the rest of the watershed, while its turbidity, TSS, ammonia, BOD and bacteria counts were all higher. Future studies and continued monitoring will need to be conducted to properly ascertain which of these differences are do to agricultural practices and which are reflective of changes occurring at the other sites.

Results from Kaseberg Creek indicate that it too is a unique system within the watershed. The pH, specific conductance, TDS, alkalinity, and nitrite are all noticeable lower than at the other monitoring sites. This uniqueness can also be seen in the physical qualities of the creek which tends to be less entrenched and supports more of a riparian area than the other creeks as a whole. Continuous monitoring and future studies will need to be conducted to better understand why the Kaseberg system has responded to development differently than Pleasant Grove Creek.

Table 3-27 Summary of Watershed Water Quality Results

Parameters	Level of Concern 1	2	3	4	5	Comments
Physical Characteristics						
Temperature			•			Summer Highs Do Not Meet Criteria
pH			•			Two Readings Outside Of Criteria Range (K1 & C1)
Specific Conductance	•					Meets Criteria
Total Dissolved Solids	•					Meets Criteria
Alkalinity as CaCO3	•					Meets Criteria
Hardness as CaCO3	•					No Concern
Sediment						
Turbidity				•		High Results at C1
Total Suspended Solids				•		High Results at C1
Settleable Solids			•			High Results at K1
Biological Factors						
Nitrate Nitrogen	•					Meets Criteria
Nitrite Nitrogen	•					Meets Criteria
Ammonia Nitrogen	•					No Concern
Phosphate Phosphorus	•					Possible Phosphorus Limited System
Biochemical Oxygen Demand		•				May Be Contributing To Low DO Values
Dissolved Oxygen				•		Summer Lows Do Not Meet Criteria
Petroleum						
Oil and Grease			•			Only Present In Spring 2005 at K1 & C1. Investigate Possible Source
Bacteria						
Total Coliform					•	Possible Health Risk Through Recreational Contact
E. coli					•	Possible Health Risk Through Recreational Contact
Organics						
Organochlorine Herbicides		•				Current Results Indicate Responsible Usage
Organophosphate Pesticides		•				Current Results Indicate Responsible Usage
Pesticides		•				Current Results Indicate Responsible Usage
Metals						
Metals (CAM 17)		•				Test Sediment To Confirm Absence In Toxic Concentrations

Recommendations

The existing monitoring plan was developed to meet the time and budgetary constraints of the project. In developing the monitoring plan, the Technical Advisory Committee (TAC) recognized that little or no water quality information was publicly available for the watershed. After having collected one year's worth of data, certain recommendations can now be made to alter the monitoring plan to improve quantity and quality of information that it can provide.

If future funding allows for continued monitoring, the following are a few recommendations to help improve the monitoring plan:

1. Test for all major cations (Ca^{2+}, MG^{2+}, K^{+}, Na^{+}) and anions (Br^{-}, Cl^{-}, Fl^{-}, SO_4^{2-}, NO_3^{-}, PO_4^{3-}) each quarter. These parameters are relatively inexpensive and provide insight to how the watershed works biogeochemically. They are also helpful in conducting charge balance and TDS comparison analysis.

2. Test for Total Kjeldhal Nitrogen (TKN) on a quarterly basis. TKN provides the missing link to understanding how the nitrogen cycle is operating within the watershed.

3. Include alkalinity in the regular quarterly analysis. The carbonate and bicarbonate concentrations are very useful in conducting charge balance and TDS comparison analyses.

4. Make sure hardness is included whenever metals are analyzed to assure proper toxicity calculations.

5. Consider replacing Oil and Grease by TPH Gasoline and TPH Diesel. This would help identify specific sources and types of petroleum pollutants.

6. Analyze sediment for metals and organics. The ability for sediment to hold pollutants is well documented, but unknown within the watershed. If results indicate none detectable concentrations

Additional resources should also be allocated to add water quality monitoring sites to help accurately determine the effects various urban and agricultural land practices have on water quality, including the elevated concentrations of *E. coli* and sources of sediment related pollutants. To accomplish this, efforts can be put forth to increase teaming with local municipalities through their NPDES Phase II programs and the local agricultural watershed group through the CVRWQCB's Irrigated Lands Waiver Program. This would lessen the costs to all parties involved, improve our understanding of the watershed, and help the overall water quality in the watershed by fostering stakeholder participation.

3.5.4 Benthic Macroinvertebrate Sampling

The California Stream Bioassessment Protocol (CSBP) is a standardized procedure for assessing the biological and physical habitat conditions of streams in California (Appendix E). The use of CSBP data is helpful in determining stream health by analyzing samples of benthic macroinvertebrates. Benthic macroinvertebrates are those organisms, such as insects, worms, or crustaceans that live in or on the bottom of a stream, or what is otherwise known as the benthos. The basis of the CSBP involves the collection of stream samples through disturbing the sediment and rubbing rocks and organic debris to dislodge the invertebrates, which are collected in a sampling net. The collected material is then preserved in a sampling jar containing formalin or ethanol, and brought to a laboratory for analysis. In the laboratory a subsample of each sample collected is sorted, until at least 300 organisms have been identified. All of the organisms collected in the subsample are identified to the species level, if possible. The invertebrate composition contained within each subsample is a representation of the stream community, and this biological community information can than be used to assess the biological status of the stream.

The samples analyzed in this study were collected using the CSBP, and a copy of the protocol is attached as Appendix E. Samples were collected from monitoring sites C1, K1, PG1 and PG2 (Figure 3-8 and Table 1-3) on April 28 and 29, 2004 and on April 26 and 27, 2005. Due to low flow conditions at C1, samples were not collected at C1 in 2005. A reach was delineated for each monitoring site, which consisted of marking the boundaries of the 100 meter section of the stream to be sampled. Then three riffles (A, B, C) within each reach were selected for sampling. Riffles are those portions of a stream where water flows swiftly over submerged obstructions, such as rocks, to produce turbulent, choppy conditions on the water surface. Once the samples from each riffle were collected and preserved in sampling jars they were transferred to Wayne Fields of Hydrozoology, a local expert on invertebrate taxonomy, who performed the sample processing and taxonomic identification (Appendix F).

In the laboratory organisms from subsamples were sorted and identified until a total number of 300 organisms (± 10%) were tallied. Once the sorting and identification process was complete, the invertebrate community data was entered into a database in order to conduct metric and statistical analysis. Metrics are terms used to describe a specific characteristic of the biological assemblage. These characteristics change predictably in response to degraded water quality conditions that are often associated with human disturbances.

Metrics

The data analysis for this study included calculations for the following set of metrics and statistical analysis. A discussion of each metric and the results are provided below. Table 3-29 and Table 3-30 at the end of this section contain the metric and statistical results for each study site.

Table 3-28 Metrics List

- Species Richness
- Abundance
- Percentage Dominant Taxon
- EPT Taxa
- Tolerance Values
- Percentage of Tolerant and Intolerant Species
- Percent Baetidae, Chironomidae, Hydropsychidae, and Diptera Species
- Percentage of Insect and Non-Insect Species
- Percentage of each Functional Feeding Group (collector-gatherer, collector-filterer, predator, shredder, scraper, and other)
- Shannon-Wiener Diversity Index

Species richness indicates the number of distinct species collected at each sampling site, and is a good indicator of the overall diversity of the invertebrate community for each location. A higher diversity, or species richness, correlates with better overall health of the stream as it suggests space, habitat, and food resources are adequate to support a variety of species. Generally samples containing 40 or more distinct species would be indicative of good water quality, while moderate water quality impacts would normally have a range of 25 to 39 distinct species. Samples containing less than 25 distinct species would indicate that water quality has been affected.

Abundance represents the actual or projected number of organisms collected in each sample, and values may vary in response to water quality impairment. If a subsample or subsamples provided the required organisms for identification, the abundance value is extrapolated from the percentage of the subsample identified. Some forms of invertebrates, such as worms, may actually proliferate in certain poor water conditions, and as such a high abundance value is not correlated with greater overall water quality.

The **percentage of dominant taxon** metric describes the percentage of each sample that was composed of the single most abundant taxon, or species. A variety of organisms, lacking dominance by any one species, is favored, as this would suggest a greater diversity among the benthic community. An increased percentage of one taxon is expected as water quality conditions decrease, due to a decreasing number of species able to survive as conditions worsen.

The **EPT taxa** metric represents the number of species present within the samples belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). With a few exceptions, most of the species from these orders are considered pollution-sensitive species, and a high diversity and number of these groups is desirable when evaluating stream conditions.

Tolerance values are assigned to each specie or family group that describes their tolerance to environmental stressors such as temperature, sedimentation and pollutants. These values range from 0 to 10, with 0 describing a very intolerant species and 10 representing a very tolerant species.

The **percentage of intolerant species** indicates the percentage of species with tolerance values from 0 to 2, while the **percentage of tolerant species** describes the percentage of those species with tolerance values of 8 to 10. A high percentage of intolerant species would indicate good water quality conditions, while a high percentage of tolerant species would indicate a higher level of water quality impairment present within the stream system.

Percent Baetidae was calculated for each site. Baetidae is the family of mayflies that belong to the Ephemeroptera order. While a majority of the Ephemeroptera family is classified as intolerant species, the family Baetidae is an exception. Mayflies of the family Baetidae are considered a more tolerant group of species, and a high percentage of these mayflies may indicate impaired water quality conditions.

Percent Hydropsychidae was calculated for each site. Hydropsychidae is the family of caddisflies belonging to the order Trichoptera. Species of this family are also considered more tolerant compared to the rest of the organisms belonging to the Trichoptera order, and a high percent Hydropsychidae would be indicative of impaired water quality conditions.

Chironomidae are midges belonging to the **Diptera** order of true flies. A low percentage of Chironomidae species is desirable since midges often increase in numbers where water quality degradation has taken place[63], and increases in the percentage of certain Chironomidae species within the invertebrate community composition can be linked to increases in nutrient enrichment and other factors that contribute to degradation in water quality. Similarly a low percentage of Diptera species is desirable, as members of the Diptera order tend to increase when water quality conditions decrease.

The **percentage of insect taxa** was calculated for each sample. An invertebrate community containing a diverse proportion of insect and non-insect species is desirable.

The **percentage of non-insect taxa** was also calculated for each sample. Due to the tendency for many non-insect species to proliferate in degraded water quality conditions due to many of these species having high tolerance values, an

[63] (Washington State Department of Ecology, 1998)

increase in the percentage of representatives from the non-insect community is expected in those streams with degraded water quality conditions.

Species or family groups are classified as belonging to one of six functional feeding groups based on their primary method of obtaining food resources. The functional groups are: **collector-filterers, collector-gatherers, predators, shredders, scrapers,** or **other** methods, such as omnivores or those that are opportunistic and vary their feeding method. The percentage of collector-gatherers and filterers would be expected to increase with impaired water quality conditions, while the percentage of shredders would be expected to decrease. The other feeding groups have variable responses to water quality degradation.

The **Shannon-Weiner Diversity Index** is a statistical formula used to evaluate the diversity within each sample and is sensitive to species richness since it takes into account the proportion of each species within a sample. Rare species carry less weight and the index accounts for differential abundance. Diversity measures are commonly used to assess the adverse effects of pollution by comparing communities. Communities with high species diversity values are usually well-balanced and least stressed while those subject to disturbance respond by losses of some species and dominance by others.

Results

Species richness for all sites ranged from 11 to 38 for both years of the study. The average species richness for C1 in 2004 was 18, with no comparison data available for 2005. In 2005 K1 showed an increase in the overall average number of species observed in 2004, increasing from 14 to an average of 21 species observed in 2005. A similar increase was observed for PG2, with the overall average increasing from 22 species in 2004 to 30 species for 2005. The species richness results for PG1 were similar for both years, which had species richness averages of 30 and 31.

Extrapolated abundance values ranged from 87 (C1A in 2004) to 8232 (PG2C, 2005) for all sites (Figure 3-40). The lowest average abundance was observed in 2004 at the C1 locations (650). The highest average abundance values were observed at PG2 (4960 for 2005) and K1 (4944 in 2004). Abundance values for K1 were slightly lower in 2005, but the year to year values for average abundance were similar (4944 and 3274). PG1 showed the greatest increase in year to year abundance, with the estimated average number of organisms increasing from 1454 to 3274.

The percentage values for the most dominant taxon ranged from 19 to 89 percent. With one exception, the most dominant taxa were comprised of non-insect species from the following invertebrate families: Tubificidae, Naididae, and Planariidae. Tubificidae and Naididae are members of the Annelida phylum of worms, and Planariidae is a member of the Platyhelminthes phylum of flatworms. One exception to non-insect taxa dominance was observed for PG1C, which was dominated by an insect species, *Simulium argus* of the Simuliidae family of black flies. K1 had the greatest year to year decrease in the percentage of dominant taxa observed with site averages decreasing from 85 percent in 2004 to 53 percent in 2005. Similarly PG2 had a decrease in the percentage of dominant taxa for 2005, and overall the percentage of dominant taxa decreased from 2004 to 2005 for all sites (Figure 3-41). No year to year comparison data was available for C1.

With the exception of PG1 and PG2, none of the sampling sites contained EPT taxa. The sites that did contain EPT taxa exhibited very low percentages of composition, with all sites containing less than 8 percent EPT taxa. For the PG locations PG1 showed a decrease in EPT observances from 2004 to 2005, while PG2 showed an increase in EPT observances for 2005, since no EPT taxa were observed at PG2 in 2004.

Average tolerance values for all sites ranged from 6.4 to 8.3, which indicates an above average tolerance value for those species present in the study. Overall the average tolerance values did not change significantly from year to year for all sites. PG1 had the lowest average tolerance values observed in 2004 (6.4, 6.5, and 6.5), while C1 had the highest average tolerance values in 2004 (8.33, 8.14, and 7.88).

None of the sampling sites contained any species classified as intolerant, while tolerant species percentages for each site ranged widely from 4 to 95 percent. The year to year trend for intolerant species percentages varied. K1 and PG1 had an increase in the percentages of intolerant species from 2004 to 2005. K1 had a maximum intolerant percentage of 15 percent in 2004, while in 2005 the percentage of intolerant species ranged increased to 16 to 57 percent. Similarly PG1 had a relatively low percentage of intolerant species, ranging from 7 to 21 percent in 2004, where the 2005 range observed jumped slightly to between 9 and 37 percent. PG2 showed a significant decrease in the percentage of intolerant species observed, with the site having a range of 60 to 72 percent in 2004, and 16 to 29 percent in 2005. While no 2005 comparison data is available for C1, it should be noted that this location had very high percent composition of intolerant species, having values between 60 and 95 percent in 2004. One anomaly is associated with C1 however, in that the C1A sample contained a single insect representative which had a tolerance value of 10. Another note worth species collected at C1 was a very large native bivalve belonging to the genus *Anodonta*.

With the exception of PG1, none of the sites contained species belonging to the Baetidae family. For PG1, the Baetidae percentage was small, with all sites having less than 3 percent Baetidae representatives, with only one of the PG1 locations containing Baetidae species in 2005 (less than 1 percent composition). Similar to the Baetidae percentages, none of the sites except for PG1 had Hydropsychidae representatives present, with all locations exhibiting 3 percent or less Hydropsychidae species composition. While all three sampling locations for PG1 contained Hydropsychidae representatives in 2004, only one of these locations contained species from this family in 2005.

All sites had less than 15 percent Chironomidae composition in 2004, with slightly higher values observed for PG1 (8 to 14 percent). These percentages increased markedly at PG1 and PG2 in 2005, with similar year to year percentages observed for K1. The overall average of Chironomidae composition at PG1 increased from 6 percent in 2004 to 23 percent in 2005. An even greater increase in the Chironomidae composition was observed for the PG2 site which had an overall average of 1 percent in 2004, while the 2005 average is 39 percent. The Diptera composition for K1 and C1 were similar with all locations containing less than 8 percent Diptera species. The PG locations exhibited a significant increase in Diptera percentages, with PG2 average percentages increasing from 1.5 percent in 2004 to 40 percent in 2005. While this increase was not as significant for PG1, PG1's average Diptera composition increased from 42 to 46 percent in successive years of sampling. When calculating the Diptera percentages for all sites we can use the Chironomidae composition as an indicator of what percentage of Diptera species present are dominated by Chironomidae species. Similar Chironomidae and Diptera percentages were observed for C1, K1, and PG2 indicating that a majority of the Diptera representatives contained in these samples were from the Chironomidae family. PG1 however had lower percentages of Chironomidae overall (12 and 26 percent) when compared to the Diptera composition (42 and 46 percent), indicating that this location had a greater diversity of Diptera families present.

C1 and K1 were dominated by non-insects for all samples collected from these locations, and this is also true for PG2, but only for the 2004 samples. For sites dominated by non-insects, the non-insect to insect ratio was generally greater than 91 percent non-insect composition, with less than 9 percent of the samples comprised of insect species. PG1 had a more even distribution of insect and non-insect species for both years of the study, with most locations having 30 to 67 percent insect composition. A significant change in this composition ratio was observed at PG2 in 2005. While the average non-insect/insect ratio was similar to C1 and K1 at PG2 in 2004, the average 2005 insect composition at this location increased to 40 percent.

The PG locations had the greatest diversity of functional feeding groups during both years of the study, while all sites except one were dominated by collector-gatherers. C1 and K1 contained more than 92 percent collector-gatherers, with all other feeding groups representing less than 7 percent of the sample. While the PG locations also had less than 5 percent composition of shredders, scrapers, and other feeding groups, these locations had a greater diversity of collector-gatherers, collector-filterers, and predators present (Table 3-29 and Table 3-30).

Shannon-Weiner Diversity Index values range from 0 to 6, with higher values indicating greater diversity. The Shannon-Weiner Diversity Index values for this study (Figure 3-40) range from 0.59 (K1C in 2004) to 2.74 (PG1C in 2004). All K1 sites had a very low diversity index in 2004, ranging from 0.59 to 0.88, suggesting very low diversity for this site. However, the diversity index increased at this location in 2005 with K1 having an average diversity index of 1.65 compared to an overall average of 0.77 observed in 2004. PG2 also exhibited an increase in year to year diversity index, increasing from 1.98 in 2004 to 2.51 in 2005. PG2 had the highest diversity index average for both years of the study (2.53). While all of the sites sampled in 2005 had a stable or higher diversity index compared to 2004, these values do not suggest high species diversity for any of the sites sampled.

Table 3-29 Data Summary of Metrics and Statistics Calculated for the 2004 Benthic Macroinvertebrate Sampling

Site Code	Site Name											
	Curry Creek 1			Kaseburg 1			Pleasant Grove 1			Pleasant Grove 2		
	C1A	C1B	C1C	K1A	K1B	K1C	PG1A	PG1B	PG1C	PG2A	PG2B	PG2C
Species Richness	11	16	26	15	13	15	30	31	38	20	19	28
Abundance [1]	87	1478	386	3576	4488	6768	1411	1280	1670	2034	2148	709
% Dominant Taxon	47.1	24.4	27.5	81.2	88.5	85.7	19.4	35.6	31.0	53.1	44.7	40.6
EPT Taxa	0	0	0	0	0	0	5	4	4	0	0	0
Average Tolerance Value	8.33	8.14	7.88	7.69	7.17	7.29	6.50	6.55	6.44	7.30	7.72	7.81
% Intolerant Taxa (0-2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Tolerant Taxa (8-10)	95.0	60.3	87.7	15.0	3.8	5.1	6.9	9.8	20.7	72.1	60.4	66.8
% Baetidae	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.6	0.6	0.0	0.0	0.0
% Hydropsychidae	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.3	0.9	0.0	0.0	0.0
% Chironomidae	4.6	0.6	0.8	3.7	5.1	7.8	14.3	8.1	13.5	0.0	0.0	2.8
% Diptera	4.6	1.0	2.1	3.7	5.6	7.8	44.6	42.2	27.9	0.3	0.6	3.1
% Insect Taxa	4.6	1.0	2.3	3.7	5.6	7.8	53.1	44.4	29.6	0.3	1.1	3.1
% Non-Insect Taxa	95.4	99.0	97.7	96.3	94.4	92.2	46.9	55.6	70.4	99.7	98.9	96.9
% Collector/Gatherers	92.5	98.5	95.9	98.0	98.4	98.5	29.4	49.1	63.0	86.5	80.9	88.7
% Collector/Filterers	1.3	0.4	2.0	0.7	0.3	0.7	45.7	37.3	22.5	0.9	0.3	3.2
% Predators	6.3	0.8	0.9	0.0	0.3	0.4	20.4	10.1	11.8	11.1	17.6	6.8
% Shredders	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Scrapers	0.0	0.4	0.3	1.0	0.8	0.4	0.0	0.3	0.3	1.5	1.2	1.3
% Other (Omnivores, Combo)	0.0	0.0	0.0	0.3	0.3	0.0	4.5	3.2	2.4	0.0	0.0	0.0
Shannon Diversity Index	1.58	1.99	2.14	0.88	0.59	0.83	2.58	2.27	2.74	1.76	1.93	2.26

Notes: 1. Abundance values were extrapolated from the percentage of each sample necessary to identify the desired number of 300 organisms for each sample, and are based on the ratio of the number of organisms collected per number of grids subsampled. However, if it was necessary to identify the entire sample, as was the case for C1 sites A and C, extrapolation was not necessary to calculate the actual number of organisms present.

Table 3-30 Data Summary of Metrics and Statistics Calculated for the 2005 Benthic Macroinvertebrate Sampling

Site Code	Site Name											
	Curry Creek 1			Kaseburg 1			Pleasant Grove 1			Pleasant Grove 2		
	C1A	C1B	C1C	K1A	K1B	K1C	PG1A	PG1B	PG1C	PG2A	PG2B	PG2C
Species Richness	NOT SAMPLED IN 2005 (Site Dry)			15	21	26	30	30	34	32	26	31
Abundance [1]				4296	1998	3528	3744	2368	4032	2400	4248	8232
% Dominant Taxon				80.4	37.8	40.1	29.5	27.4	24.7	34.3	15.3	21.3
EPT Taxa				0	0	0	0	2	2	1	1	0
Average Tolerance Value				7.47	7.67	7.38	6.97	7.10	6.71	7.16	7.19	7.52
% Intolerant Taxa (0-2)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Tolerant Taxa (8-10)				16.2	57.1	24.8	36.5	34.5	9.2	15.7	28.8	16.4
% Baetidae				0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
% Hydropsychidae				0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0
% Chironomidae				0.3	8.7	6.1	19.2	26.7	23.5	42.0	38.4	37.9
% Diptera				0.3	8.7	6.5	32.7	37.8	64.6	42.0	38.4	38.5
% Insect Taxa				1.7	9.0	7.1	32.7	38.9	67.3	43.3	39.0	38.5
% Non-Insect Taxa				98.3	91.0	92.9	67.3	61.1	32.7	56.7	61.0	61.5
% Collector/Gatherers				98.3	97.6	97.3	78.2	83.1	49.4	76.3	75.7	77.8
% Collector/Filterers				0.0	0.0	0.0	14.1	13.2	43.8	13.3	18.4	16.4
% Predators				1.4	0.6	1.0	6.4	2.4	5.4	6.0	5.4	5.3
% Shredders				0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
% Scrapers				0.3	1.8	1.4	1.3	1.4	1.5	4.3	0.6	0.6
% Other (Omnivores, Combo)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shannon Diversity Index				0.86	1.95	2.15	2.45	2.55	2.60	2.42	2.57	2.54

Discussion

In 2004 values observed for species richness, percent dominant taxon, tolerance values, functional feeding group percentages and the ratio of non-insects to insects were better for PG1, suggesting higher water quality at PG1 when compared to the other sampling sites of the study. This is further supported by the presence of EPT taxa at PG1, with no EPT observances at C1, K1, or PG2. PG1 also included tolerant representatives from the Baetidae and Hydropsychidae family, and the highest percentage of members of the Diptera family. Although this could be interpreted as an indicator of degraded water quality conditions, the presence of these species may be attributed to a higher species diversity observed at PG1. A higher diversity is also suggested by the distribution of functional feeding groups present at PG1. Overall the data collected at the PG1 site was similar for both years of the study, with a few exceptions. While the PG1 site contained a more even distribution of functional feeding groups in 2004, collector-gatherer species dominated two of the three PG1 samples in 2005, with these two samples also containing a higher percentage of non-insects compared to insect species.

The data collected in 2005 shows a year to year improvement in species richness, percent dominant taxon, tolerance values, and Shannon diversity values for the K1 and PG2 sites. This is especially true for the PG2 site, which showed a significant reduction in the percentage of dominant taxa, and the percentage of tolerant taxa, suggesting an improvement in water quality conditions within the area. This is also supported by a more equal distribution of the percentage of insects and non-insects observed at PG2 in 2005.

While abundances were highest at K1 in 2004 and at PG2 in 2005, high abundances do not automatically suggest better water quality. This is because an increased number of tolerant species is often correlated to degraded water quality conditions. This was taken into consideration when evaluating conditions of each location, especially when other metric values were taken into consideration. While in 2004 K1 had the highest abundance, K1 also had the lowest species richness, the highest percentage of dominant taxa, and the lowest diversity index for that year. However, these values exhibited an improvement in 2005 for K1, suggesting an improvement in water quality conditions. One exception to the 2004 metrics values for K1 that is not indicative of degraded water quality was that this site had the lowest average percentage of tolerant species present, although the data collected in 2005 shows an increased amount of tolerant species present. Although a higher percentage of tolerant species were observed at K1 in 2005, suggesting the possibility of poor water quality at this site, K1 showed significant improvement as mentioned above in other areas such as Shannon diversity and species richness.

In 2004 metrics scores for C1 and PG2 varied between the values observed for PG1 and K1, with the exception of the percentage of tolerant species, which was on average 60 percent or greater for these two sites. While no 2005 comparison data was available for C1, C1 had the highest overall average tolerance values, while a slight improvement in average tolerance values was observed at PG2 in 2005. Degraded water quality at C1 is suggested by the lower observed abundances, as two of the samples had their entire contents identified to meet the 300 organism threshold, including one sample that only contained 87 organisms. While several of the 2004 metrics for PG2 suggest degraded water quality conditions (high percentage on non-insects and high percentage of collector-gatherers), other metrics for the site suggest only marginal water quality degradation (marginal percent dominance and the presence of up predators). However, these degraded and marginally degraded parameters showed improvement in the 2005 data for PG2. Other promising indicators for improved water quality conditions for PG2 include an increase in species richness, abundance, and Shannon-Diversity index values.

Summary

While flow, temperature, and weather conditions varied for each site from year to year, which plays a role in the existing species compositions observed, several assumptions can be made from the analysis of the benthic macroinvertebrate data. When comparing the sites to each other, the data suggests that PG1 has a greater diversity of species and contains a more varied composition of both insect and non-insect taxa, which could be attributed to better water quality and habitat conditions. While this was not evident in 2004 at K1 and PG2, an improvement in overall conditions at these two locations were observed in 2005, suggesting improved water quality conditions to support a higher species richness and diversity. This is especially true for K1 which had the lowest species richness, the highest percentage of the dominant taxa, and the lowest Shannon-Diversity Index values when compared to the other sites in both years of the study, indicating that water quality conditions at this site were the most degraded in relation to the other locations. These conditions improved at K1 in 2005, suggesting an improvement in overall water conditions at this location. Although PG2 and C1 also had indicators of poor to moderately poor water quality conditions, with the data suggesting better water quality at PG2 compared to C1 for 2004. However, PG2 exhibited significant improvement in metric scores in 2005. Based on the data analysis, if the watershed is evaluated on a water quality gradient, the best water quality conditions would be expected at PG1, followed by PG2, C1 (2004 data only), and finally by K1.

Some of the known contributors to water quality degradation at C1 and K1 include known beaver dam site locations and the contribution of agricultural runoff. A beaver dam is located upstream of K1, and conditions at K1 may be linked the contribution of significant amounts of organic nutrients and materials from the upstream location of the dam. Conditions at C1 may be affected by the increased agricultural runoff and sedimentation that occurs in this area when compared to other sites within the watershed.

Supplementing the current benthic macroinvertebrate data set with data collected during future studies will help to accurate determine water quality trends throughout the watershed, by comparing data collected over time.

Figure 3-40 Shannon-Diversity Index and Abundance

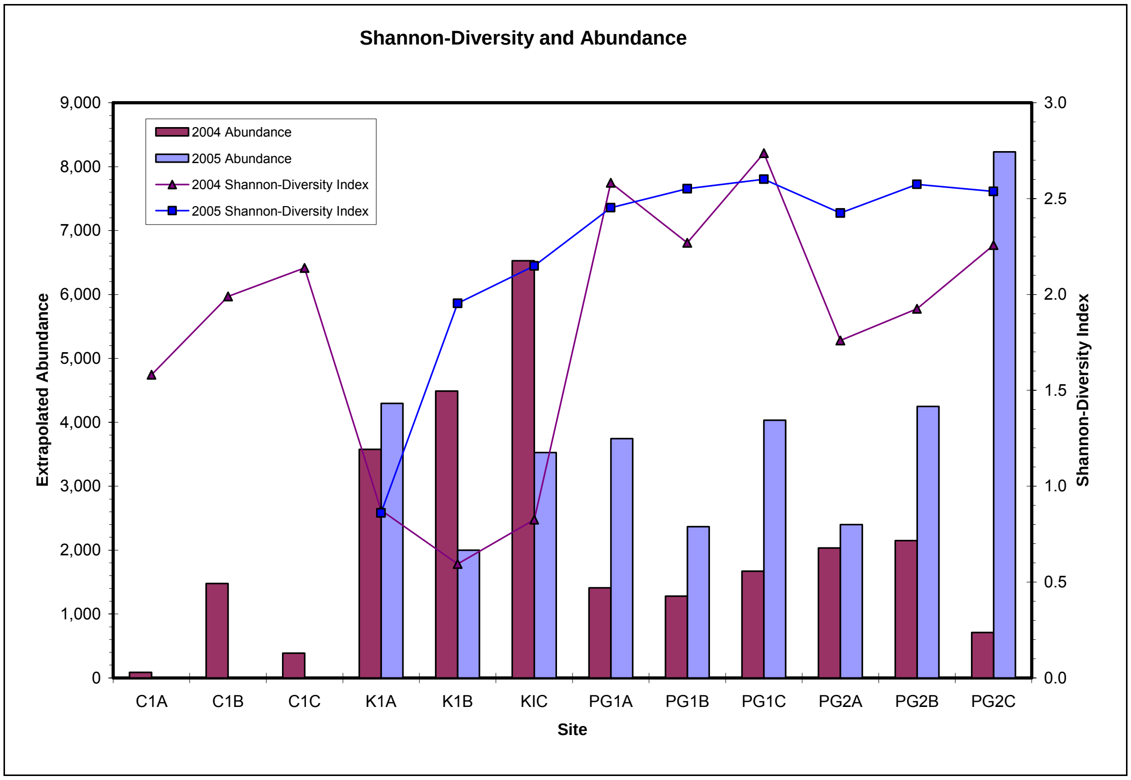
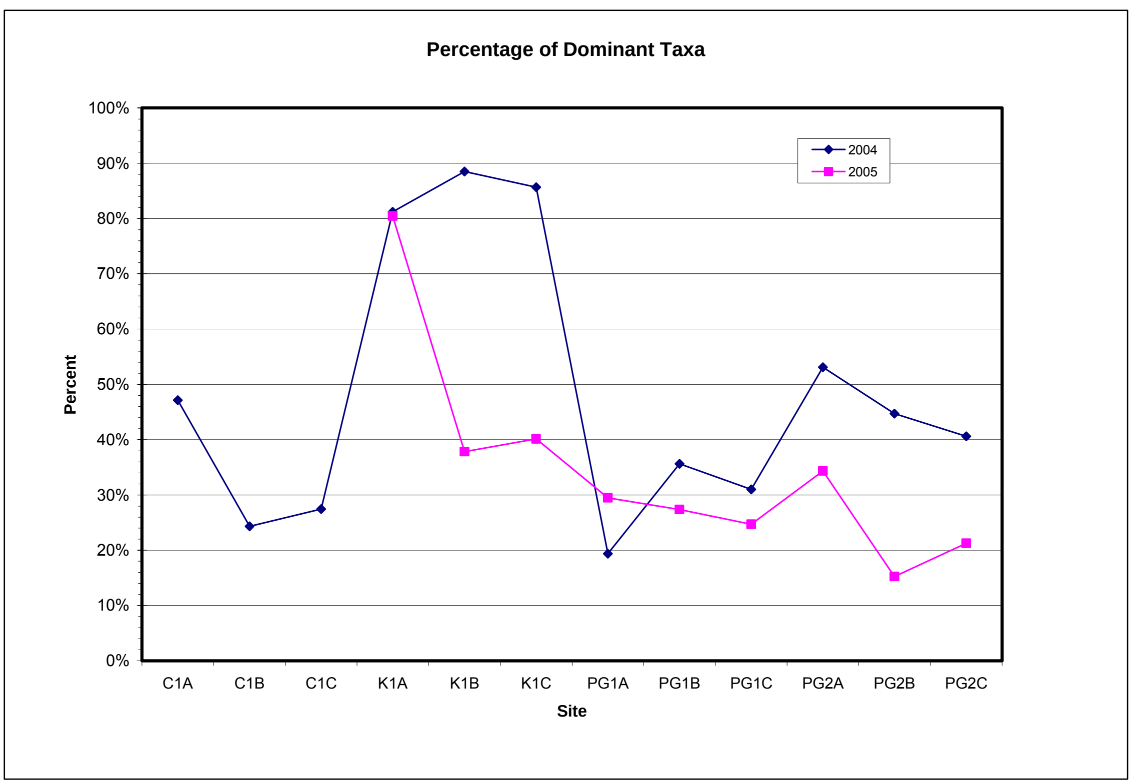


Figure 3-41 Percentage of Dominant Species



3.6 HABITAT AND KEY RESOURCES

Table 3-31 lists the species that were selected by Placer County to be included in this study. The primary factor influencing these selections was the presence or likely occurrence of a listed species (Federal or State threatened or endangered or species of special concern) in the watershed. The scientific name, common name and the species listed status are indicated in the table.

Table 3-31 Sensitive Species Considered in ERP

SCIENTIFIC NAME	COMMON NAME	TE STATUS
PLANTS:		
Gratiola heterosepala	Bogg's Lake hedge-hyssop	CNPS List 1B
Downingia pusilla	Dwarf downingia	CNPS List 2
Legenere limosa	Legenere	CNPS List 1B, BLM Sensitive
Juncus leiospermus	Red Bluff dwarf rush	CNPS List 1B, BLM Sensitive
BIRDS:		
Buteo swainsoni	Swainson's hawk	CA Threatened
Athene cunicularia hypugaea	California burrowing owl	USFWS Species of Special Concern
Icteria virens	Yellow-breasted chat	CDFG Species of Special Concern
Lanius ludovicianus	Loggerhead shrike	CDFG Species of Special Concern
REPTILES AND AMPHIBIANS:		
Spea hammondii	Western spadefoot toad	USFWS Species of Concern
Ambystoma californiense	Tiger salamander	Federal Threatened Species
Thamnophis couchi gigas	Giant Garter Snake	Federal & State Threatened
Rana aurora draytonii	California red-legged frog	Federal Threatened Species
INVERTEBRATES:		
Branchinecta lynchi	Vernal pool fairy shrimp	Federal Threatened Species

SCIENTIFIC NAME	COMMON NAME	TE STATUS
Lepidurus packardi	Vernal pool tadpole shrimp	Federal Endangered Species
Linderiella occidentalis	California linderiella	USFWS Species of Concern
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle	Federal Threatened Species

3.6.1 Sensitive Species Habitat Requirements

This section summarizes the various habitats required by the selected species. In addition to the species' common and scientific names is a two letter code used in Table 3-32 to map species to habitat type in the land use/land cover maps used in this project.

Plants

Bogg's Lake Hedge-Hyssop (Gratiola heterosepala) Gh

Bogg's Lake hedge-hyssop occurs along lake margins and vernal pools. In vernal pools, it inhabits barren, muddy areas on extremely shallow soils. Populations are usually composed of scattered individuals, but plants have been observed aggregated in groups within cattle hoof prints. Bogg's Lake hedge-hyssop often grows in association with bractless hedge-hyssop (*Gratiola ebracteata*) and Orcutt's quillwort (*Isoetes orcuttii*) in sparsely vegetated areas. Other vernal pool associates include hairy clover-fern (*Marsilea vestita* ssp. *vestita*), popcornflowers (*Plagiobothrys* spp.), downingias (*Downingia* spp.) Howell's quillwort (*Isoetes howellii*), Nuttall's quillwort (*Isoetes nuttallii*), coyote thistle (*Eryngium* spp.), woolly-heads (*Psilocarphus* spp.), creeping spikerush (*Eleocharis macrostachya*), and smooth goldfields (*Lasthenia glaberrima*).

Dwarf Downingia (*Downingia pusilla*) Dp

Dwarf Downingia is primarily associated with northern claypan vernal pools in the central Sacramento Valley and in northern hardpan vernal pools in the Sierra Nevada foothills. It occurs in vernal pools and adjacent vernal swales, as well as, in artificial features within the vernal pool landscape, such as stock ponds, roadside ditches, gravel pits, tire ruts, and scraped depressions. The vernal pools in which this species occurs have been described as having a short hydroperiod (i.e., "flashy" vernal pools), although it also occurs at the margins of wetlands with longer periods of inundation, such as sloughs and seasonal marsh.

Legenere (*Legenere limosa*) (Ll)

Legenere is found in vernal pools and swales, seasonal marshes, artificial ponds, floodplains of intermittent streams, as well as, other seasonally inundated habitats. Wetlands that support legenere are typically inundated for long periods and range in size. This species occurs in northern basalt flow, northern claypan, northern hardpan, northern volcanic ash flow, and northern volcanic mudflow vernal pool types. Surrounding plant communities are typically grasslands.

Red Bluff Dwarf Rush (*Juncus leiospermus var. leiospermus*) (Jl)

Red Bluff dwarf rush is known to occur in a variety of habitats, including meadows and seeps, vernal pools, and vernally mesic areas in chaparral, cismontane woodland, and valley and foothill grassland from. Very little information exists on the specific habitat requirements of Red Bluff dwarf rush; however, information in the California Natural Diversity Database (CNDDB) indicates that the species prefers areas that have saturated soils during the rainy season (November–April), such as vernal pools and vernally mesic areas.

Wildlife

Invertebrates

California Linderiella (*Linderiella occidentalis*) Lo

California linderiella inhabit rain-filled, ephemeral pools (i.e., vernal pools) that form in depressions, usually in annual grassland communities. Pools must fill frequently and persist long enough for the species to complete its lifecycle, which takes place entirely within vernal pools. Compared to other endemic, Central Valley fairy shrimp, the California linderiella is the most tolerant of warm water and consequent low dissolved oxygen (Helm 1998). Most pools occupied by California linderiella are vegetated and contain clear water. However, it is not uncommon to observe California linderiella in mud-bottomed pools with slightly turbid water. California linderiella typically occupies reasonably large pools and may occur in roadside ditches in the Central Valley (Eriksen and Belk 1999).

Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) Dc

Habitat for valley elderberry longhorn beetle (VELB) consists of elderberry shrubs (*Sambucus* sp.) with a basal diameter greater than 2.54 centimeters (1 inch) occurring in upland riparian forests or elderberry savannas adjacent to riparian vegetation. Individual VELB rely on the same elderberry plant (or clump of plants) throughout the life cycle. Adults feed on the elderberry leaves and flowers. Mating pairs are typically observed on an elderberry shrub. Eggs are laid on the stem or leaves of an elderberry plant and the larval and pupal stages develop within the elderberry stem pith. Elderberry usually co-occurs with other woody riparian plants, including Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), various willows (*Salix* spp.), wild grape (*Vitis californica*), blackberry (*Rubus* sp.), and poison-oak (*Toxicodendron diversilobum*).

Vernal Pool Fairy Shrimp (*Branchinecta lynchi*) Bl

Vernal pool fairy shrimp inhabit rain-filled ephemeral pools (i.e., vernal pools) that form in depressions, usually in grassland habitats. Pools must fill frequently and persist long enough for the species to complete its lifecycle, which takes place entirely within vernal pools. Pools occupied by vernal pool fairy shrimp often have grass or mud bottoms and clear to tea-colored water; they are often in basalt flow depression pools in unplowed grasslands. Water chemistry is key in determining fairy shrimp occurrence; alkalinity, total dissolved solids (TDS), and pH are some of the most important factors (Eriksen and Belk 1999). Vernal pool fairy shrimp inhabit alkaline pools, ephemeral drainages, rock outcrop pools, ditches, stream oxbows, stock ponds, vernal pools, vernal swales, and other seasonal wetlands. Occupied habitats range in size from rock outcrop pools as small as 0.8 square meter (1 square yard) to large vernal pools up to 11 acres. The maximum potential water depth of occupied habitat ranges from 1.2 to 48 inches (Helm 1998; Eriksen and Belk 1999).

Vernal Pool Tadpole Shrimp (*Lepidurus packardi*) Lp

Vernal pool tadpole shrimp occur in a variety of natural and artificial seasonally inundated habitats. Helm (1998) observed vernal pool tadpole shrimp occurring in vernal pools (natural, artificial, and constructed), seasonal wetlands (natural and artificial), alkaline pools, clay flats, vernal swales, stock ponds, railroad right-of-way pools, roadside ditches, and road rut pools resulting from vehicular activity. Occupied pools and wetlands typically have highly turbid waters or aquatic vegetation that may provide shelter from predators.

Reptiles and Amphibians

Giant Garter Snake (*Thamnophis couchi gigas*) Tg

Giant garter snakes typically inhabit small mammal burrows and other soil crevices above flood elevations throughout its winter dormancy period, November through February. The breeding season extends through March and April and females give birth from late July through September. Habitat requirements include an adequate water supply through the snake’s active period of early spring through late fall; emergent wetland vegetation for escape and cover habitat during the active season; grassy banks and openings for basking; and upland vegetation for escape during high water periods (USFWS, 2004).

California Tiger Salamander (*Ambystoma californiense*) Ac

California tiger salamanders require two major habitat components: aquatic breeding sites and terrestrial aestivation or refuge sites. California tiger salamanders inhabit valley and foothill grasslands and the grassy understory of open woodlands, usually within one mile of water. California tiger salamander is terrestrial as an adult and spends most of its time underground in subterranean refugia, especially ground squirrel burrows and occasionally human-made structures, emerging only for brief periods to breed. California tiger salamanders also use logs, piles of lumber, and shrinkswell cracks in the ground for cover. Tiger salamanders breed and lay their eggs primarily in vernal pools and other ephemeral ponds that fill in the winter and often dry by summer and sometimes use permanent human-made ponds (e.g., stock ponds), reservoirs, and small lakes. Because tiger salamanders have an approximately 10-week-long developmental period, the longest lasting seasonal ponds or vernal pools are the most suitable type of breeding habitat; such pools are also typically the largest. Moreover, large vernal pool complexes, rather than isolated pools, probably offer the best quality habitat; these areas can support a mixture of core breeding sites and nearby refuge habitat.

California Red-legged Frog (*Rana aurora draytonii*) Ra

California red-legged frogs have been found at elevations from sea level to about 5,000 feet. They use a variety of habitat types including various aquatic, riparian and upland habitats. California red-legged frogs breed in aquatic habitats such as marshes, ponds, deep pools and backwaters in streams and creeks, lagoons, and estuaries. Breeding adults are often associated with dense, shrubby riparian or emergent vegetation and areas with deep (>27 inches [0.7 meter]) still or slow-moving waters. However, these frogs often successfully breed in artificial ponds with little or no emergent vegetation and have been observed in stream reaches with no riparian vegetation. An important factor influencing the suitability of aquatic breeding sites is the general lack of introduced aquatic predators such as bullfrog (*Rana catesbeiana*).

Western Spadefoot Toad (*Scaphiopus hammondii*) Sh

Western spadefoot toads can be found in dry grassland habitat close to seasonal wetlands such as vernal pool complexes, typically near extensive areas of friable (but not usually sandy) soil (Stebbins 1951). Suitable pools exhibit sufficient depth and surface area to persist at least several weeks. Although spadefoot populations primarily occur in grassland settings, they are occasionally found in valley-foothill woodlands (Zeiner et al. 1988). Western spadefoots can also be found in creeks, drainages, and ponds. Although the spatial requirements of western spadefoots are unknown, it has been postulated that populations are more likely to persist in large complexes of vernal pools than in small, isolated pools. It is frequently assumed that spadefoots require loose soils for subsurface dormancy however, there is some evidence that spadefoots may also use rodent burrows (Stebbins 1951). Also, most sites that support western spadefoots are moderately to heavily grazed.

Birds

Loggerhead Shrike (*Lanius ludovicianus*) Lu

Loggerhead shrikes are a common resident and winter visitor in lowlands and foothills throughout California. Shrikes prefer open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches. The highest density of shrikes occurs in open-canopied, valley foothill hardwood, valley foothill hardwood-conifer and valley foothill riparian habitats. Shrikes occur only rarely in heavily urbanized areas, but are often found in open cropland. They build well-concealed nests on stable branches in densely-foliaged shrubs or trees.

Swainson's Hawk (*Buteo swainsoni*) Bs

In California, Swainson's hawk's nests are generally found in scattered trees or along riparian systems adjacent to agricultural fields or pastures (CDFG, 1994). However, nests have been known to occur in riparian woodlands, roadside trees, trees along field borders, isolated trees, small groves, trees in windbreaks, and on the edges of remnant oak woodlands. Suitable habitat generally consists of large, flat, open, undeveloped landscapes with adjacent or easily accessible grasslands or agricultural fields for foraging. Swainson's hawks usually nest in large, native trees such as valley oaks (*Quercus lobata*), cottonwoods (*Populus fremontia*), and willows (*Salix* spp.), although nonnative trees such as eucalyptus (*Eucalyptus* spp.) are also used. Suitable agricultural crops include a mixture of hay, grain, and row crops with low-lying vegetation that support adequate rodent prey populations.

Western Burrowing Owl (Athene cunicularia hypugea) Ah

Burrowing owls are found in open, dry grasslands, agricultural and range lands, and desert habitats. Burrowing owls are often associated with California ground squirrel (*Spermophila beechei)* colonies as they often utilize abandoned ground squirrel burrows. They can also inhabit grass, forb, and shrub stages of various pine (*Pinus* spp.) habitats. They can be found at elevations ranging from 200 feet below sea level to 9,000 feet above. Burrowing owls commonly perch on fence posts or on mounds outside the burrow. They have been found at the margins of airports and golf courses and in vacant urban lots. They are active day and night, but are usually less active in the peak of the day. During daylight hours, they are often found perched within the burrow entrance or within the immediate burrow vicinity.

Yellow-breasted Chat (*Icteria virens*) Iv

Yellow-breasted chat may be seen in the Central Valley as a rare breeder of riparian systems and during spring and fall migration. It is an uncommon and secretive bird in dense brushy patches and hedgerows in open, sunny areas (Sibley, 2003). Yellow-breasted chat often occurs along the edge of woods and dense thickets in low wet places near streams, pond edges or swamps. Nests are cup-shaped and made of coarse materials such as leaves, bark placed in dense or thorny thickets. Chats nest from mid-May through late-June.

3.6.2 Sensitive Species Existing Habitat

Table 3-32 presents existing acreages for land cover types potentially used by the selected sensitive species as breeding, nesting or foraging habitat. The land use designation is from the Placer County Land Cover database developed for the HCP/NCCP project. Also noted in the table is a 2 letter designator for the species types potentially found in that vegetation class (see section 1.6.1) and the total acres of that type within the watershed. Refer to Figure 3-5 for spatial distribution of these land cover patches.

Table 3-32 Sensitive Species Existing Habitat

LAND USE DESCRIPTION	SPECIES	ACREAGE
Agricultural	Bs, Ah, Lu	2,971.8
Alfalfa	Bs, Ah	14.5
Blue Oak Woodland	Bs, Ah, Dc	245.5
Disturbed Lands	Bs, Ah	405.7
Freshwater Emergent Wetland	Jl, Ra	40.2
Foothill Hardwood	Bs, Dc, Sh	260.9
Golf Course	Ah	961.9
Annual Grassland	Bs, Ah, Lu, Ac	15,418.6
Lacustrine	Dp, Ll, Ra, Iv	26.3
Oak-Woodland Savanna	Bs, Ah, Lu, Sh,	286.8
Pasture	Bs, Ac, Lu, Sh	14.0
Rice	Bs, Tg	4,738.6
Riparian	Bs, Dc, Ra, Iv, Tg	423.1
Rivers, Lakes, Reservoir, Canal	Li, Ra, Tg, Iv	5.1
Stock Pond	Gh, Bl, Lp, Dp, Ll, Jl, Lo, Ac, Ra, Sh	2.6
Seasonal Wetland	Gh, Bl, Lp, Dp, Ll, Jl, Lo, Sh	156.1
Unidentified Croplands	Bs, Ah	2,222.7
Urban Riparian	Bs, Dc	4.3
Urban Woodland	Bs	40.4
Valley Oak Woodland	Bs, Dc, Lu	201.8
Vernal Pool Complex-High Density	Gh, Bl, Lp, Dp, Ll, Jl, Lo, Sh, Ac	466.5
Vernal Pool Complex-Medium Density	Gh, Bl, Lp, Dp, Ll, Jl, Lo, Sh, Ac	55.5
Vernal Pool	Gh, Bl, Lp, Dp, Ll, Jl, Lo, Sh, Ac	26.2
Vernal Pool Complex-Low Density	Gh, Bl, Lp, Dp, Ll, Jl, Lo, Sh, Ac	153.3

Table 3-33 summarizes the habitat for the selected sensitive species under existing land use-land cover conditions. The data presented is focused on both total habitat and patch statistics. As used in this study, patches are defined as homogeneous units of land use/land cover utilized as habitat by the species under consideration. Patch statistics presented include total potential habitat, maximum and average patch sizes, number of patches, average perimeter and perimeter complexity. Perimeter complexity is defined to be average perimeter divided by the perimeter of a circle having area equal to the average area. A perimeter complexity of two would have twice the perimeter of a circle of the same area. Patches with more complex perimeters have more edge and less interior habitat than patches with perimeter complexities close to one. Minimum patch statistics are not presented, because they are close to zero for all species. In general, higher values are desirable for potential habitat and maximum and average patch sizes. Number of patches provides some idea about how fragmented the available habitat is. While the data presented in Table 3-33 does provide a brief overview of the current state of habitat for sensitive species, it will become more useful when it is compared to likely and desired future conditions in the following chapter.

Table 3-33 Species Habitat Statistics

SPECIES	POTENTIAL HABITAT	MAXIMUM PATCH SIZE	AVERAGE PATCH SIZE	NUMBER OF PATCHES	AVERAGE PERIMETER (FT)	PERIMETER COMPLEXITY
Bogg's Lake Hedge-hyssop (Gh)	860	252	13.0	66	2,672	1.00
Vernal pool fairy shrimp (Bl)	860	252	13.0	66	2,672	1.00
Vernal pool tadpole shrimp (Lp)	860	252	13.0	66	2,672	1.00
Swainson's hawk (Bs)	27,249	9,461	105.2	259	9,357	1.23
California burrowing owl (Ah)	22,542	9,461	95.1	237	8,401	1.16
Dwarf downingia (Dp)	887	252	12.1	73	2,646	1.03
Legenere (Li)	897	252	10.1	88	2,342	0.99
Red Bluff dwarf rush (Jl)	900	252	11.9	76	2,618	1.03
California linderiella (Lo)	860	252	13.0	66	2,672	1.00
Loggerhead shrike (Lu)	18,893	9,461	115.9	163	9,254	1.16
Tiger salamander (Ac)	16,123	9,461	91.6	176	7,796	1.10
Elderberry longhorn beetle (Dc)	1,136	196	25.8	44	9,844	2.62
Calif. red-legged frog (Ra)	503	196	10.0	50	4,913	2.09
Western spadefoot toad (Sh)	1,422	252	13.7	104	3,590	1.31
Giant garter snake (Tg)	5,172	2,307	129.2	40	11,759	1.40
Yellow-breasted chat (Iv)	460	196	13.1	35	6,273	2.34

NOTE: All sizes in acres, unless otherwise indicated

3.6.3 Condition of Key Resources

Table 3-34 presents the current state of habitat for the sensitive species within the watershed. The state, or conservation value, is based upon known presence of the species in the watershed and suitability of habitat in the watershed and in western Placer County.

Table 3-34 State of Habitat and Stressors for Sensitive Species

SPECIES	CONSERVATION VALUE OF EXISITING HABITAT[1]	COMMON STRESSORS
Bogg's Lake Hedge-hyssop	M	Ag, U, O, ORV, H, C
Vernal pool fairy shrimp	H	Ag, U, H
Vernal pool tadpole shrimp	M	Ag, U, H
Swainson's hawk	M	Ag, U, H, PS, F
California burrowing owl	L	Ag, U, PS
Dwarf downingia	M	Ag, U, O, ORV, H, C
Legenere	M	Ag, U, O, ORV, H, C
Red Bluff dwarf rush	M	Ag, U, O, ORV, H, C
California linderiella	M	Ag, U, H
Loggerhead shrike	M	Ag, U, F, PS, P, ORV, R
Tiger salamander	L	Ag, U, H, P, PS, ORV, F, R
Elderberry longhorn beetle	M	Ag, U, H
Calif. red-legged frog	L	Ag, U, H, P, PS, ORV, F, R
Western spadefoot toad	L	Ag, U, H, P, PS, ORV, F, R
Yellow-breasted chat	L	F, P, H, U
Giant garter snake	M	Ag, H, U

[1] H=High, M=Medium, L=Low

Ag = ag conversion

U = urbanization

O = overgrazing

ORV = offroad vehicle

H = hydrologic alteration

C = competition with exotic species

P = predation by introduced species

PS = pesticides

F = habitat fragmention

R = road construction

While conservation of habitat in the watershed for all of the ERP species is important, it may be more important for those that are very rare or for whom a significant amount of remaining habitat is located in the watershed. For example, existing high quality habitat for very rare species that only exist within the watershed would be a relatively more important conservation goal than preserving habitat for species that occur in multiple locations outside of the watershed. This approach provides a perspective on how important the specific habitat within the watershed is to the overall persistence of the species.

Table 3-35 presents the rationale behind the conservation rating in Table 3-34. Occurrences of the species in the California Natural Diversity Database (CNDDB) are listed, along with their status, the rationale for the assigned rating, and a more detailed summary of the common stressors. The CNDDB is a database maintained by the CDFG of observations of special status species.

Table 3-35 System Utilized in Rating Habitat for Sensitive Species									
Species	Number of CNDDB Occurrences (2005 statewide	Number of CNDDB Occurrences (2005) Phase 1 PCCP	Approximate Fraction of Phase 1 PCCP occurrences in PG/CC watershed	Placer Legacy Category	Status	Other	PG/CC Conservation Value	Rationale	Common Stressors
Bogg's Lake Hedge-hyssop	86	3	1/3	Class 1	CNDDB List 1B, CA Endangered		M	CA Endangered Species, present in watershed, but watershed does not support a major concentration of this species.	agricultural and urban development, overgrazing, offroad vehicle traffic, hydrologic alteration, competion with exotics (medusahead)
Vernal pool fairy shrimp	365	38	1/3	Class 1	Fed Threatened	watershed includes critical habitat for the species, and is within draft recovery unit	H	Fed Threatened Species. Significant proportion is in Placer County, approximately 1/4 of the habitat of which is in the watershed, with designated critical habitat.	habitat loss and degradation resulting from urban development and agriculture.
Vernal pool tadpole shrimp	195	2	1/2	Class 1	Fed Endangered	0.006	M	Fed Endangered species, but watershed does not support a major concentration of this species.	habitat loss and degradation resulting from urban development and agriculture.
Swainson's hawk	1,380	2 (CDFG found 7 active nests)	1	Class 1	CA Threatened	JSA bird study for PCCP shows watershed to support an important bird concentration area for grassland/pasture	M	CA Threatened species, but watershed does not support a major concentration of Swainson's hawks - distibution is spotty in Placer County as compared with Yolo and Sacramento Counties, and other primary concentration areas.	Habitat loss through urban conversion, and ag conversion to orchards and vineyards. Shooting. Pesticide poisoning of prey. Competition from other raptors. Predation by crows, great horned owls. Human disturbance at nest sites.
Western burrowing owl	703	1	1	Class 3	CA and Fed Species of Special Concern	Burrowing Owls are considered rare in Placer County (Webb 2003). However, JSA bird study for PCCP shows watershed to support an important bird concentration area for grassland/pasture	L	Fairly widespread species. Distribution in Placer County is spotty, and the watershed does not support a major concentration of burrowing owls.	Conversion of grassland to agriculture, urbanization, poisoning of ground squirrels
Dwarf downingia	110	15	1/2	Class 3	CNPS List 2		M	Species rare in CA but more common elsewhere. Placer County supports a fairly signficant proportion of CA population, of which approximately 1/3 is in watershed.	competition with invasive species
Legenere	59	3	2/3	Class 3	CNPS List 1B		M	Species is rare in CA and elsewhere. Only one known occurrence in watershed, but species is difficult to detect so more may be present.	competition with invasive species
Red Bluff dwarf rush	38	1	1	Class 3	CNPS List 1B		M	Species is rare in CA and elsewhere. Only one known occurrence Placer County, within watershed. Southernmost occurrence for species.	urban development, agricultural conversion,
California linderiella	231	26	1/2	Class 3	none		M	Significant proportion of known localities from Placer County, 1/3 of which is from watershed.	habitat loss and degradation resulting from urban development and agriculture.

Table 3-35 System Utilized in Rating Habitat for Sensitive Species										
Species	Number of CNDDB Occurrences (2005 statewide	Number of CNDDB Occurrences (2005) Phase 1 PCCP	Approximate Fraction of Phase 1 PCCP occurrences in PG/CC watershed	Placer Legacy Category	Status	Other	PG/CC Conservation Value	Rationale	Common Stressors
Loggerhead shrike	5	0	0	none	CA Species of Concern		M	Species widespread, but the species is not common in western Placer County.	Habitat loss due to conversion of agricultural fields and urbanization has resulted in loss of perch sites and shrub habitat for nesting.
California tiger salamander	779	0	0	Class 2	Fed Threatened		L	Species not known to occur in Placer County.	urban development, agricultural conversion, habitat fragmentation, road construction, vehicle mortality, overgrazing, changes in hydroperiod, introduced predators, water diversions and impoundments, pesticides, pathenogens.
Valley Elderberry Longhorn Beetle	190	7	0	Class 1	Fed Threatened		M	Federally Threatened species, present in watershed, but watershed does not support a major concentration of this species.	Riparian habitat loss and fragmentation, damming and channel maintenance, invasion of Argentine ant
California red-legged frog	762	0	0	Class 2	Fed Threatened, CA species of concern	Historic occurrences within watershed	L	Historic occurrences from watershed, but species is believed to be extirpated from western Placer County.	urban development, agricultural conversion, habitat fragmentation, road construction, vehicle mortality, overgrazing, changes in hydroperiod, introduced predators, water diversions and impoundments, pesticides, pathenogens.
Western spadefoot toad	299	4	3/4	Class 3	CA Species of Concern		L	Planning area does not include major concentrations of this species, and species is not extremely limited in distribution.	urban development, agricultural conversion, habitat fragmentation, road construction, vehicle mortality
Yellow-breasted chat	80	0	0	Class 3	CA Species of Concern	only yellow-breasted chats nests are considered sensitive under this designation.	L	Small acreage of riparian habitat available in Phase 1 Planning Area. Uncommon and localized in CA. No known populations or territories in Placer County.	Habitat loss and fragmentation due to urban development. Nest parasitism by brown-headed cowbirds, an exotic species. Flood control and riverine channelization eliminates early successional riparian habitat.
Giant garter snake	167	0	0	Class 2	CA Threatened, Fed Threatened	Extirpated from much of historical distribution in Sacramento Valley.	M	No known occurrences of GGS in Phase 1 planning area, although suitable habitat occurs throughout along drainage networks.	Agricultural and flood control activities have extirpated GGS from much of former range. Upstream watershed modifications, urbanization and ag development have occurred within valley floor wetlands. Selenium contamination and impaired water quality. Conversion of rice fields to orchards or row-crops.

3.7 POTENTIAL RESTORATION SITES

Figure 3-42 presents a generalized classification of the named creeks and their major tributaries within the Pleasant Grove and Curry Creek watershed. This classification was developed through an aerial photographic assessment of three factors:

- Channel structure: presence of a natural meander pattern and indications of past disturbance or channelization.
- Riparian vegetation: presence of large trees that overhang the channel.
- Available floodplain: presence of undeveloped land adjacent to the channel that could be inundated in a storm event without a large impact to public health and safety or financial loss.

Each of these factors was assigned a rating of “1” to “3”, with “1” indicating poor quality with respect to that factor (a heavily modified channel, absence of significant riparian vegetation, or constraining land uses) and “3” indicating a relatively healthy system with respect to that factor (little evidence of channel disturbance, a healthy riparian tree canopy, or significant buffers of undeveloped land surrounding the creek). The combined rating factor used in Figure 3-42 is a sum of these three individual rating factors.

The ratings were assigned by stream “reach”, with the beginning and end of the “reach” being defined by either a change in one or more of the three factors or the physical termination of the vector within the GIS, which often occurs at a confluence. The base utilized for the GIS was the USGS National Hydrography Database (NHD). Stream “reaches” were named using a two letter designator for the stream (e.g. “PG” for “Pleasant Grove”) and a numeric designator starting at “1” at the confluence with the Pleasant Grove Canal and incrementing upstream. “PG-10” is an example of a reach on Pleasant Grove Creek. Major unnamed tributaries were designated by their parent stream (e.g. “PG” for “Pleasant Grove”), followed by dash, then a letter designator (e.g. “A”), followed by a numeric designator starting at “1” at the confluence with the main stem. PG-A3 is an example of a reach on one of the major unnamed tributaries to Pleasant Grove Creek.

3.7.1 Pleasant Grove Creek

As can be seen in Figure 3-42, the Pleasant Grove creek system has moderate to good structure in the lower to middle watershed. The primary creek channels do not appear to have been heavily modified and available floodplains are generous due to the agricultural nature of the lower watershed. Riparian vegetation varies from good to poor, generally depending upon grazing and agricultural practices. Several of the Pleasant Grove tributaries in the middle watershed have sections that appear to have been channelized to better meet the perceived needs of agricultural land use (PG-D2, PG-D6, PG-D7). These stream reaches could benefit from cooperative agreements between the County and local landowners to improve creek structure in those areas where the stream has been straightened and better manage riparian vegetation in those areas where the creek is denuded. One segment of a tributary in the middle watershed (PG-E5) has been confined where it flows through a residential subdivision. Due to lack of space for reintroducing creek structure, activities should focus on encouraging residents to plant riparian trees and shrubs and manage runoff to protect water quality in the creek.

The main stem of Pleasant Grove Creek could also benefit from improved riparian vegetation along many reaches. A very good section in the middle watershed in the vicinity of the confluence with tributary “D” could be used as a reference reach for creek restoration projects in the watershed (PG11-17). This section exhibits good channel structure, a healthy riparian tree canopy and a wide, connected floodplain. The City of Roseville will soon be implementing the multifunctional 1,700 acre Reason Farms project in this area which will include flood control, habitat, public open space, and recreation features. It provides an excellent model for how to integrate development impacts with environmentally sensitive urban infrastructure planning.

In the more urbanized areas of the middle to upper watershed, where Pleasant Grove Creek flows through the Cities of Roseville and Rocklin, the quality of the creek channel, riparian vegetation and available floodplain along the main stem varies from good to poor. The poor sections are typically lacking in channel structure and large riparian vegetation due to development adjacent to the creek. In the vicinity of Industrial Avenue and Highway 65, the creek corridor is in a degraded condition. Just downstream of Industrial, the creek channel appears to have been straightened (PG-33, 34), and from this section to the upstream side of Highway 65, riparian vegetation is relatively sparse (PG-35). Restoration activities that would be appropriate for this area include introduction of in-channel structures and/or channel realignment to reintroduce meanders into the straightened section as well as replanting of riparian trees and shrubs with appropriate beaver protection to safeguard the young plantings.

Approximately 1500 feet downstream from Sunset Boulevard, a section of the main stem of Pleasant Grove Creek appears to have been manipulated by the adjacent development (PG-39) on the south side. A bike path runs along the north side between the creek and a community park with sports fields. Many cattails (Typha sp.) choke the channel in this area, and some willows are regenerating, particularly on the north bank. Some conifers and deciduous shade trees have been planted along the bike path adjacent to the park. A path from the residential development dead-ends at the creek across from the park; a bridge may be planned at this location to span the creek and provide access to the park for residents of the development. Stream structure could be improved in this section through realignment or in-channel structures. Terrestrial and aquatic habitats could be improved through planting of riparian trees and shrubs.

Further upstream, on both sides of Farrier Road is a section of the main stem with residential development on both sides (PG41, 42, 43). The available floodplain is restricted, channel structure is relatively uniform, and riparian vegetation is moderate. A large beaver dam on the downstream end of the development has impounded water throughout this section to several hundred feet east of Farrier Drive. Because of the impounded water, many water fowl are actively using this site. Most of the native trees along this stretch, including willows, valley oaks and interior live oaks are protected from beaver by wire mesh around their trunks. Where Farrier Drive crosses the creek, seven wide open-bottom culverts span the creek, creating an opening perhaps fifty feet across. Upstream of the beaver pond, channel structure is moderate to good, with a meandering, braided low flow channel within the larger flood control channel. Because of the constrained space and the beaver presence, options are limited for improving the creek in this reach; however, improved beaver management, planting additional riparian trees and shrubs, and possibly installing some in-channel structures could potentially improve habitat.

A short reach immediately upstream of this section could use additional improvement to stream structure through planting of riparian trees and shrubs (PG43). The channel appears to have been straightened at some point in the past, but as in upper part of the downstream reach, a relatively stable, braided meandering low-flow channel has developed within the larger floodplain.

Upstream of Stanford Ranch Road, the creek channel is straightened for an approximately 1100 foot section that has few riparian trees and shrubs (PG44). Above this point, the channel shows less sign of disturbance, although vegetation is still sparse (PG45). The creek in these reaches appears to have been channelized at some point in the past. Banks are steep, probably 1.5:1, and, while a braided, meandering low-flow channel has formed within the banks, the bankfull condition appears to occupy the entire bottom of the larger channel. Some willows are growing on the channel banks, but shading of the stream is very low. Restoration activities in the section upstream of Stanford Ranch Road should include channel modifications to redefine the bankfull channel, possibly laying back of the creek banks and revegetation. Planting of riparian trees and shrubs should be continued upstream to Wickford Boulevard.

Other than the named creeks of South Branch Pleasant Grove Creek and Kaseberg Creek, the major tributaries to Pleasant Grove Creek in the urbanized area of the watershed are in a less healthy state than the main stem. Unnamed tributary “A” (Figure 3-42) is significantly degraded in the vicinity of Highway 65 and Blue Oaks Boulevard (PG-A3, A4). The channel appears to have been straightened in this section; it is an open channel with few riparian trees and shrubs. Additionally, runoff from Highway 65 has the potential to introduce automotive pollutants such as oil and grease to the water body. Sufficient space exists in this area to increase the channel diversity through realignment and laying back of the banks to reconnect the creek to its floodplain. Additionally, planting of a healthy riparian buffer will reduce the likelihood of pollutants from the adjacent roadways migrating into the creek.

Further upstream (PG-A5-7), the stream has more structure, including some meander bends; however, riparian vegetation is still sparse. Revegetation activities on these reaches should attempt to restore riparian vegetation appropriate to the soils and hydrologic regime of the creek and its floodplain.

Unnamed tributary “B” has good form and structure until approximately 1000 feet downstream of Cincinnati Avenue. The short reach downstream of Cincinnati Avenue has moderate structure but needs revegetation (PG-B7). A small tributary that joins the downstream end of this reach appears to be heavily impacted by beaver activity (PG-B-A1). Upstream of Cincinnati Avenue, this tributary is channelized through an industrial complex containing several warehouses and other industrial uses (PG-B8, B9). Due to the extreme confinement of the channel, little can be done to restore this reach unless the land is redeveloped in the future; however, the County should work with the land owner/operator to ensure that water quality is not being compromised in this reach. Additionally, in some areas, channel banks could be eased to create a more natural creek profile. Upstream of PG-B9, east of Industrial Boulevard, the creek channel forms a more natural meandering pattern with sufficient buffer for a healthy riparian buffer to be planted. This buffer would help preserve water quality from the adjacent industrial land uses.

Tributary “C” is somewhat degraded approximately 2600 feet upstream of its confluence with the main stem (PG-C2). Channel structure is moderate in this reach, with good meanders, although the creek is slightly incised (perhaps one to two feet). Riparian vegetation is moderate, with several large deciduous oaks, willow and live oak, but could be improved by additional plantings. This is an area of light-industrial land use with the potential for lower water quality due to runoff from adjacent land uses entering the creek. Enhanced riparian buffers would help to reduce the potential for this to occur.

Upstream of this point (PG-C3, C4), the creek has been channelized and riparian vegetation is very sparse. The section adjacent to the CAT Storage Store has been landscaped with cobble, shrubs such as rosemary and ceonothus and some trees. There is some evidence of scouring and minor incision just downstream of the culverts under Blue Oaks Boulevard. In the section west of the railroad tracks, the creek meanders through an open field. No riparian vegetation is growing in this stretch and the creek has incised approximately four feet into a cemented sandstone-like material. Several large stone outcrops are present near the creek, and a small headcut or eddy erosional hotspot has formed upstream of one cluster of rocks. Some minor modification of the creek channel may be possible to ease the banks to reduce incision. Revegetation may be the most effective restoration technique for improving creek habitat and function in this reach, but additional soils studies need to be done to fully understand the dynamics of incision into this soil type. It is possible that the cemented hardpan layer will prevent any large trees or shrubs from growing in this area, although there are large oaks on PG-C2 located less than ¼ mile downstream.

3.7.2 South Branch Pleasant Grove Creek[64]

Degraded reaches along South Pleasant Grove Creek occur primarily in the upper watershed. In the reach from Washington Boulevard to Diamond Oaks Road, the creek is little more than an open channel between box culverts (SP16). Four roads cross the creek within 800 feet, and it is bounded by residential properties. The available floodplain in this area is less than 100 feet. Probably the most that can be done to improve habitat along this stretch is to plant some willows and cottonwoods, although studies will be needed to determine the potential effect of woody vegetation on floodwater conveyance within the channel.

Further upstream, where South Branch Pleasant Grove Creek flows through Diamond Oaks Golf Course (SP-17-19), channel structure could benefit by the use of in-stream structures to create diversity. Riparian vegetation in this section is moderate, but could still benefit from additional willow and cottonwood plantings.

Planting of riparian vegetation in the reach between Roseville Parkway and the headwaters, adjacent to the Galleria Mall (SP-22), would be beneficial to creek health.

In addition to the above measures, two areas present opportunities for additional restoration. The first is downstream of Pleasant Grove Boulevard (SP-11,12).

[64] Foothill Associates, 2004.

In this reach, overland flow from residential yards enters the creek. Runoff from residential property has been found to carry pesticides such as Diazinon[65] and fertilizers from yard maintenance and soaps used in washing cars. These outfalls should be studied to determine if some mitigation measures can be installed to treat or slow runoff prior to its entering the creek system. These measures may take the form of detention ponds or swales.

Downstream of Woodcrest Oaks Boulevard, South Branch Pleasant Grove Creek has high quality habitat, good channel structure and generous available floodplain. Even so, the creek quality could be further enhanced through improved sediment management from residential properties. Outfalls in this area dump directly into the creek, and source controls are the best methods for improving water quality in these outfalls.

Between Heritage Drive and Chipshot Way, South Branch Pleasant Grove Creek flows through approximately 20 acres of open space (SP-20). Riparian vegetation is sparse in this reach, and channel structure has been heavily modified. A flood control structure 950 feet upstream of Chip Shot Way backs up water into this area. Improvements to this reach include riparian plantings, in-stream structures and channel modifications to improve channel diversity and connectivity to the floodplain.

3.7.3 Kaseberg Creek[66]

Upstream of County Club Drive, the middle fork of Kaseberg Creek has been channelized (KA6-KA8). This concrete lined channel flows between residential neighborhoods and has little habitat value for fish or wildlife, and little can be done to improve this section due to space constraints and the existing flood control structures. One small section west of Foothills Boulevard remains unchannelized, but development of this parcel is likely to occur in the near future. While it would benefit local bird species and other wildlife to keep this channel remnant in a natural state, especially if it were replanted with native riparian species, the total benefit to the Kaseberg Creek system would be minor. Probably, the greatest benefit to this channelized creek reach would be realized by homeowner outreach that targets reduction of household and landscape maintenance chemicals in the creek by educating residents on the effects of landscape and household maintenance chemicals on creek systems. Additional improvement of water quality could come from reducing runoff through reducing irrigation, installing cisterns, and increasing permeable paving and treating street runoff with oil/water separators, vegetated swales or filtration devices.

[65] Schiff, 2001

[66] Foothill Associates, 2004

The headwaters of the north branch of Kaseberg Creek, at the east end of Sierra Pines Golf Course, has been channelized for 1300 feet starting from where it exits the culvert 600 feet east of Green Grove Lane and extending west into the golf course (KA-B4). The channel is not armored in this stretch, and the creek could be restored to a more natural configuration through channel realignment and in-stream structures. Willows and Cottonwoods should also be planted along the banks, which will make a more attractive, as well as a more ecologically sound, creek.

Finally, the segment of Kaseberg between Timeberrose Way and Fiddyment Road is denuded of riparian trees and shrubs, has little floodplain, and uniform channel structure (KA3, KA4). In-stream structures to create channel diversity and improved riparian cover would increase habitat in this short reach.

In general, channel structure on Kaseberg Creek is moderate to good. Several areas on the creek would benefit from planting of native riparian trees and shrubs. In addition to those mentioned above, reaches that would benefit from revegetation include on the mainstem between Timberrose Lane and Del Web Boulevard (KA5), on the south branch just downstream of Pleasant Grove Boulevard (KA9), on the middle branch between Woodcreek Oaks Boulevard and Country Club Drive (KA-A5), and on the south branch between Pleasant Grove Boulevard and Woodcreek Oaks Boulevard (KA-12).

On the middle branch of Kaseberg Creek, the reach near Mahany Park is close to a reference reach condition for the creeks in the upper Pleasant Grove watershed (KA-A4). Restoration activities on this reach will help it significantly toward this goal, which will then provide a condition by which other upper watershed creeks can be compared. Activities that should be undertaken on this reach include planting of riparian trees and shrubs and channel modifications to enhance sinuosity and structural diversity.

3.7.4 Curry Creek

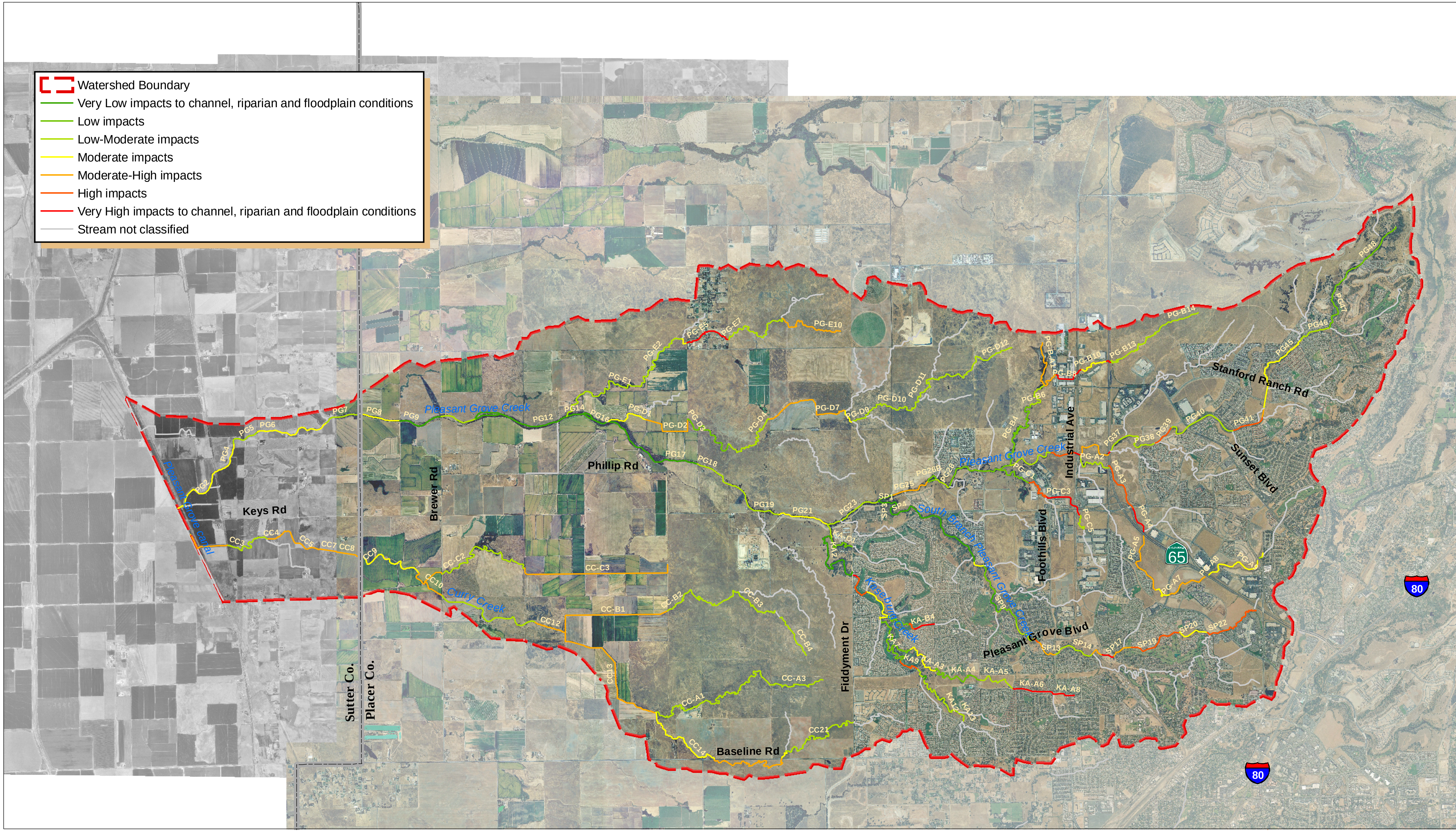
The Curry Creek system shows greater evidence of manipulation than the main stem and tributaries of Pleasant Grove Creek. Many reaches along the main stem of Curry Creek appear to have been straightened for agricultural purposes (CC1, CC2, CC4-8, CC10, CC12, and CC13). CC13 in particular has been channelized to conform to the edges of the adjacent agricultural fields and exhibits little structural diversity. These reaches have also been denuded of a healthy riparian buffer, which exacerbates problems with agricultural runoff degrading creek water quality. Public jurisdictions should work to develop incentives for farmers and ranchers to undertake restoration projects to reintroduce meanders, riffles and pools into the creek corridors and plant healthy riparian buffers between agricultural fields/pastures and the stream.

Other reaches along the main stem (CC9, CC14- CC21) have moderate to good stream structure, but little to no riparian vegetation. Planting additional riparian trees and shrubs along these reaches will help to improve habitat and water quality; however, further study of each site is necessary to determine the appropriate vegetation based upon depth of soil, available moisture, depth to water table, etc.

Major unnamed tributaries to Curry Creek exhibit much the same character. Tributary "A" has good structure and a large available floodplain but little riparian vegetation and could be improved by restoration of a healthy riparian buffer.

The upper reaches of tributary "B" are much the same as "A"; however, the lower reach above the confluence with the main stem has been channelized to conform to agricultural fields as has the main stem in this area. Restoration activities appropriate to this reach involve working with the local landowners to restore a more natural creek structure as well as plant riparian trees and shrubs.

Tributary "C" is the opposite of tributary "B". The upper reaches have been channelized, perhaps by the same agricultural operator that straightened the lower reach of tributary "B", and the lower reaches have good structure but lack riparian vegetation. Actions similar to those recommended for tributary "B" and the main stem in this area will also be appropriate on tributary "C".



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LANDSCAPE ARCHITECTURE

GENERALIZED ASSESSMENT OF CREEKS

PLEASANT GROVE/CURRY CREEK ECOSYSTEM RESTORATION PLAN

N
0 2,500 5,000
SCALE IN FEET

FIGURE 3-42

Springfield:\Pleasant_Grove_and_Curry_Creek\GIS_Projects\WDGT_Report_Figures\Fig-3-11_stream_classification